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ABSTRACT

This common core curriculum guide for agribusiness presents material for eight units of instruction. Following the objectives of the guide and a description of the curriculum materials, lessons are provided in the following subject areas: (1) orientation, (2) leadership, (3) careers, (4) supervised occupational education, (5) mechanics, (6) animal science, (7) horticulture, and (8) conservation of natural resources. Provided within each of the lessons are lesson objectives, motivation ideas, references, outlines, teaching learning activities, and a suggested evaluation. The leadership unit examines public speaking skills and provides practice in conducting meetings. Information on selecting a career and applying for and working at a job is given in the careers unit. The supervised occupational education unit presents information on how to summarize and analyze the job that the student selected in the previous year. The mechanics unit introduces skills that are of importance to people employed in agribusiness occupations. The three technical agribusiness units, animal science, horticulture, and conservation of natural resources, examine specialized information and provide practice in skills from each major agribusiness area. (LRA)

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AGRIBUSINESS II

Agricultural Education Section
PURDUE UNIVERSITY

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AGRIBUSINESS II

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I. Introductory Information

The information contained in the following pages is essential to the effective use of these instructional materials. Reviewing this information will aid the instructor in understanding the performance based vocational education concept for which this material is designed. This introductory section will serve to help find information, interface this course into the vocational agribusiness program schedule and to purchase materials.

II. Description of Agribusiness II

Agribusiness II is the second volume of curriculum materials consisting of eight units which provide skills and information basic to agribusiness. An orientation unit provides students with a review of the agribusiness program. A unit on leadership includes public speaking skills and practice in planning the operations of an organization and holding meetings. Following the orientation and leadership units is a unit on careers that provides information on selecting a career and applying for and working at a job. The supervised occupational education unit is a continuation from the previous year that finalizes the year's work. The lesson also provides information on how to summarize and analyze the job that the student had selected the previous year. The mechanics unit is designed to include skills that are of importance to people employed in agribusiness occupations. There are three technical agribusiness units; Animal Science, Horticulture and Conservation of Natural Resources. These units branch out from the more basic Soil and Plant Science Unit in Agribusiness I, to examine and practice some of the more specialized information and skills of each major agribusiness area.

III. Objectives

1. Describe the vocational agribusiness program.
2. Develop and demonstrate leadership ability in agribusiness.
3. Prepare information and materials needed to be hired into a job.
4. Show proper interview procedures.
5. Summarize and analyze the previous year's supervised occupational experience.
6. Prepare for a continued or new supervised occupational experience.
7. Demonstrate mechanical skills.
8. Select a livestock enterprise based on land, capitol, labor, and available buildings and equipment.
9. Select livestock based on body conformation and performance records.
10. Demonstrate common livestock management practices.
11. Prepare a feed ration based on a given digestive system and nutrient requirement.
12. Describe animal disease control practices for specific situations.
13. List the careers that are available in Horticulture.
14. Propogate selected plants.
15. Identify different specialized growing structures from pictures or examples.

16. Demonstrate plant care practices for selected plants.
17. Plan a simple landscape design for a home.
18. List the various fruits and vegetable crops that are of importance to Indiana.
19. Explain the economic considerations of vegetable and fruit production in Indiana.
20. Describe the pro and con considerations for growing fruits or vegetables.
21. Define terms related to natural resources.
22. Describe how man has affected and can further alter the environment.
23. Demonstrate basic forest management practices.
24. List environmental problems that concern foresters and determine some various solutions.
25. Classify wildlife and fish species into various categories.
26. Demonstrate wildlife and fishery management practices.

IV. Use of Material

This book is developed in a loose leaf form to enable the easy removal or addition of information

This section on the use of materials explains what is included in the units and offers suggestions for effective use of materials.

The units are numbered separately with the page numbers in the upper right corner of each page. For example: (VI-24) indicates the twenty-fourth page of the sixth unit which is the Animal Science unit. The transparency masters have the letter "T" and the handouts have the letter "H" as a suffix to the page number.

A. Unit Introduction

There are eight units following the introduction: Orientation, Leadership, Careers, Supervised Occupational Education, Mechanics, Animal Science, Horticulture, and Conservation of Natural Resources. Tab dividers seperate each unit.

The introduction should be read in advance to allow for preparation for the unit's presentation. Each unit introduction contains the broad objectives that recommend the learning that is to take place in the unit. The introduction provides a list of the unit lessons, information of references, and other teaching sources that could be used in teaching the lessons. It also provides addresses as to where the reference can be obtained. The titles of handouts and transparency masters used in the lessons of each unit are located in a list in the back part of each introduction.

B. Lessons

The lesson plans include objectives, motivation, references, outline, teaching learning activities, and suggested evaluation methods.

1. Objectives: Specific objectives have been prepared for each lesson. These objectives reflect the learning outcomes of the students for each lesson. The objectives provide the framework in the lesson as long as the teacher agrees with them. The lesson objectives are intended to contribute to the unit objectives which in turn contribute to the course objectives.

2. Motivation: A motivation idea has been written for each lesson to stimulate interest at the beginning or during a lesson. The teacher should be reminded that the one motivation idea would not be enough alone, but requires continuous remotivation throughout the lesson. Hopefully, some of the activities described in the latter part of the lesson plan will help fulfill that purpose.

3. References: A list of reference materials are provided in each lesson and should be reviewed before presentation of the lesson. The references are listed to provide needed materials for the lesson's presentation and class activities. The list of materials are to be viewed as an added suggestion for information to supplement the lesson outline. It is important that the teacher see the reference materials that are to be used by the students during the learning activities. Transparencies and handouts located at the end of the lesson are listed in order.

4. Outline: The outline gives a brief description of subject matter information to aid the teacher in planning and presenting the lesson. The outline information is written to provide the teacher with additional information and can be provided to the students in the form it is written in the lesson.

5. Teaching Learning Activities: The activities provide suggested guidelines for accomplishing lesson objectives. The activities relate to items in the outline and are planned for maintaining student interest in the lesson. More procedures have been listed than can be used in many of the lessons. Teachers should feel free to add or substitute ideas or activities to accomplish the lesson activities.

6. Suggested Evaluation: Different methods of evaluating student progress are suggested at the end of the lesson. These suggestions are based on the learning activities provided in the lesson. This part is left open for each teacher.

V. Suggested Guidelines

The information in this book provides for more instruction than could be taught in the second year program in a normal school year. It is left to the decision of each teacher as to which lessons will best meet the needs of the students and the individual community. Each teacher will have to decide how much information and activities to use to provide the best learning experience for the students.

A. Estimated Time Allocated

	Unit	Days (Hrs.)
I.	Orientation	5
II.	Leadership	25
	A. Principles B. FFA C. Parliamentary Procedure	
III.	Careers	20
IV.	Supervised Occupational Education	20
V.	Mechanics	90
VI.	Animal Science	80
VII.	Horticulture	40
VIII.	Natural Resources	60

B. Sample Program Guidelines

Courses could be set up emphasizing a specific technical area such as Natural Resources, Animal Science, Horticulture or Mechanics. Lessons from the units on Orientation, Leadership, Careers, Supervised Occupational Education or Mechanics could be inserted into the courses where they would best apply.

The courses could be set up on a year, semester, or other unit of time basis.

For example:

1. A production agribusiness program's offering might be set up as a semester or year course in animal science with lessons from Orientation, Leadership, Careers, S.O.E., or Mechanics that would apply to the program.

2. A mechanics course could be developed from the materials with lessons from other units used where applicable.

3. A sales and service course might be developed with the careers unit as its foundation with lessons from other units included.

UNIT I

ORIENTATION
Introduction to the Unit

In this unit the agribusiness student will be informed as to what is to be offered in the second year of the agribusiness program.

The unit will also provide a review of information concerning vocational agribusiness and its many areas. Specific information as to the requirements that will have to be met in order to complete the Agribusiness II course will be provided.

LESSONS:

1. Course Content and Requirements
2. Review of Vocational Agribusiness

OBJECTIVES:

Upon completion of this unit the student will be able to:

1. Define terms associated with the Vocational agribusiness program.
2. Describe the units that are to be covered in the course.
3. Discuss the importance of agriculture in society.

MOTIVATION:

The teacher should review the many learning activities that are planned during the year that would be of interest to the students.

TEACHING REFERENCES:

A. General References:

   1. Exploring Agriculture, Prentice-Hall, Inc.
      Englewood Cliffs, New Jersey 07632

OTHER REFERENCES

1. Plant Science, Instructional Materials Laboratory,
   University of Missouri-Columbia
   Department of Practical Arts and Vocational Technical Education
   and Career and Adult Education
   State Department of Elementary and Secondary Education
   Jefferson City, Missouri

HANDOUTS:

1. "Interest Evaluation Sheet"

LESSON 1: COURSE CONTENT AND REQUIREMENTS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. List the requirements of the course.
2. List the recommended activities.
3. Write a description of the different subjects to be covered in Agribusiness II.
4. Define vocational agribusiness and list some of the areas that are represented by it.

MOTIVATION:

Give the students the course outline and discuss what is to be taught in each unit.

REFERENCES:

Student Handbook of Rules - Provided by local school

Handout: "Course Outline"

OUTLINE:

A. Requirements of the Course - Prepared by the Teacher

B. Recommended Activities

   1. Receiving the chapter membership degree in FFA
   2. Take part in FFA activities
      a. Judging
      b. Leadership
      c. Committee work
      d. Officer elections
      e. Other - fund drives, parties, field trips

C. Subject Areas to be Covered (Teacher Selected)

1. Orientation
2. Leadership
3. Careers
4. Supervised Occupational Education
5. Mechanics
6. Animal Science
7. Horticulture
8. Natural Resources

D. Vocational Agribusiness - Preparing for a Career in Production, Resource Management, Processing or Distribution of Food and Fiber.

E. Areas in Vocational Agribusiness

1. Production
2. Supplies and Service
3. Mechanics
4. Products
5. Horticulture
6. Natural Resources

TEACHING LEARNING ACTIVITIES:

1. Review with the students the general class procedures that will be routine for each day.
2. Use the unit introduction motivation to describe some of the activities that will be used to aid the students in learning during the year.
3. Discuss with the students the various units that will be taught and emphasize specific lessons in each unit.

4. Review the definitions involved with vocational agribusiness. Discuss with students the major areas of employment in Vocational Agribusiness.

5. Review with the students how the FFA helps to prepare them for work. Emphasize that they can get much more out of the program if they participate in the FFA.

SUGGESTED EVALUATION:

1. Quiz students on material discussed during the lesson presentation.

LESSON 2: REVIEW VOCATIONAL AGRIBUSINESS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. List three reasons why he/she is in the Vocational Agribusiness program.
2. Explain in writing why having an individual occupational enterprise is part of the program.
3. Rate their personal interests in the different areas of Vocational Agribusiness.
4. Write a paragraph explaining why agribusiness is important to the community, country and the world.

MOTIVATION:

Present statistics showing costs to produce vs. prices charged for agricultural commodities. Show prices of food in other countries compared to the prices in this country.

REFERENCES:

Exploring Agriculture, Prentice-Hall, Inc.

Handout: "Interest Evaluation Sheet"

OUTLINE:

A. Reasons for Taking Agribusiness
    1. Have an interest in agriculture
    2. Have experience in agricultural occupations
    3. Expect to be employed in an agribusiness after high school graduation

4. Plan to enter an agricultural college.

5. Are presently employed in an agribusiness and need some basic training.

B. Importance of Having Individual Occupational Enterprises

1. To gain practical experience.

2. To gain leadership training and learn to work with others.

3. To obtain a working knowledge of the business.

4. To provide a direct application for what is learned in the classroom.

C. Importance of Agribusiness

1. Community

    a. Provides employment.
    b. Brings in revenue to the community.
    c. Provides business leadership in the community.
    d. Affects social interests in the community.

        (1) Agricultural related organizations
        (2) School system
        (3) Churches
        (4) General living conditions

2. Indiana is a major farming state.

    a. 1969 farm marketings returned 799 million dollars for livestock and 597 million dollars to crops.
    b. In 1970 Indiana ranked third in the nation in the production of soybeans and swine, fifth in corn, and fifteenth in beef cattle.
    c. Other crops and livestock include oats, barley, sorgum grains, legumes, and pasture grasses, dairy, poultry and sheep.

3. Country and world.

    a. The United States is a major food producing country and exports its surplus foods
    b. Leading commodities exported are

        (1) Oil seeds and products
        (2) Wheat and flour
        (3) Feed grains
        (4) Animal products

(5) Tobacco
(6) Fruits and Vegetables
(7) Cotton
(8) Rice

c. The U.S. population growth has slowed considerably but other world population has not. This means that the demand for commodities is increasing. The major countries the U.S. exports to are:

(1) Japan
(2) West Germany
(3) Canada
(4) United Kingdom
(5) The Netherlands
(6) India
(7) Italy
(8) Spain
(9) Belgium and Luxembourg
(10)Korea

d. Although the U.S. exports many commodities it also is the second largest importer of agricultural products (5.8 billion).
West Germany is the largest importer of Ag. products.

(1) The number one product imported by the U.S. is coffee.
(2) The second most imported product is meat and meat products.
(3) The third most imported product is fruit and nuts.

e. The U.S. exports much more agricultural products than it imports. The exports affect our country's relations with other nations. The U.S. faces three world challenges.

(1) Commercial relations with developing nations of the world.
(2) Our policies concerning trade problems of the less developed countries of the free world.
(3) Our trade policies with Eastern Europe, the U.S.S.R., China, and other communist countries.

TEACHING LEARNING ACTIVITIES:

1. Have students write a list of reasons why they are enrolled in vocational agribusiness. When giving this assignment explain that what is written may have some bearing on the semester courses that may be offered for their junior and senior years.

2. Discuss the reasons with the students and tie them into the statements in the outline.

3. Ask the class why having occupational enterprises is included in the vocational agribusiness program. List the students' statements on the chalk board.

4. Discuss the answers to the question posed in previous activity.

5. Hand out the interest evaluation sheet and have students rate the areas in the order of interest.

6. Draw a chart on the board to list the students' ratings of agribusiness areas and discuss each of these areas. Determine from student discussion the knowledge the students have about the areas. Have students rerate the areas. If the teacher feels that discussion has changed some of the students' opinions.

7. Ask the class why agribusiness is important to the community. List the reasons on the chalk board. See the outline for examples. Discuss each of the answers.

8. What information is available to indicate that Indiana is a major farming state? Allow students to use references to prove that Indiana's agribusiness industry is important.

9. Why is the United States considered important in the agriculture of the world? Use this question to begin discussion of the United States' role as a trading nation.

10. Provide some sub-problems to aid in answering the question in number 9.

    a. What does the United States export?
    b. Who does the U.S. export to?
    c. Does the U.S. import agricultural produce? If so, what items and who from?
    d. What are some problems that affect the U.S. trading with certain countries?

11. Allow students time to use reference materials to answer the subproblems. Discuss the answers during class.

SUGGESTED EVALUATION:

1. A written quiz of material discussed in class.

2. Evaluate the students notes during class.

I-10H

INTEREST EVALUATION SHEET

(10-most interested, 1-not interested)

Please check each item under the number corresponding to your interest.

	10	9	8	7	6	5	4	3	2	1
1. Production										
a. Farmer										
b. Part-time Farmer										
c. Farm Equipment Operator										
d. Stockyards worker										
e. Feed lot worker										
2. Supplies and Service										
a. Supplies Manager										
b. Supplies Salesman										
c. Chemical Applicator										
d. Artificial Insemination Technician										
3. Mechanics										
a. Equipment Serviceman										
b. Machinery Salesman										
c. Machinery Parts Man										
d. Mechanics Specialist										
e. Ag Engineer										
f. Welder										
g. Farm Construction worker										
4. Products										
a. Fruit and Vegetable Market Manager										
b. Livestock Buyer										
c. Dairy Processing Equipment Operator										
d. Meat Processing										
e. Quality Control Technician										
5. Horticulture										
a. Florist										
b. Greenhouse Manager										
c. Golf Course Superintendent										
d. Landscape Technician										
6. Natural Resources										
a. Soil Cons. Aid										
b. Soil Cons. worker										
c. Fishery Biologist										
d. Game Biologist										
e. Wildlife Conservation Officer										
f. Forester										
g. Forestry Aid										
h. Logger										
i. Saw Mill Operator										
j. Timber Buyer										
7. Agribusiness Information										
a. Country Extension Agent										
b. Vocational Agribusiness Teacher										
c. Agricultural Writer										
d. Radio-TV Farm Director										
e. Agricultural Scientist										

UNIT II

LEADERSHIP
Introduction to the Unit

To organize, conduct activities, and communicate are important to a person's social life as well as the business life. This unit will provide some basic skills for the student to learn how to organize a project and conduct well planned meetings. The student will also receive some basic training in public speaking to help in organization of thoughts and accurate communication.

LESSONS:

1. Evaluating and Planning a Program of Activities
2. Public Speaking
3. Review Parliamentary Procedure

OBJECTIVES:

At the completion of this unit the student will be able to:

1. Participate in planning a program of activities for the chapter.
2. Present a three to eight minute speech.
3. Conduct a meeting by using correct parliamentary procedure.

MOTIVATION:

Why should we study leadership in a vocational agribusiness program?

Suggested answers:

1. To develop an ability to communicate on the job.
2. To develop the leadership abilities to increase possibilities of employee advancement.
3. To fill leadership roles in the community.
4. To fill leadership roles in agribusiness organizations.

5. To successfully support the agribusiness industry through communication skills.

TEACHING REFERENCES:

A. General References:

  1. Official Manual, Future Farmers of America: National FFA Supply Service
  2. FFA Advisor's Handbook, National FFA Supply Service
  3. FFA Handbook, Indiana FFA Association
  4. FFA Activity Guide, Indiana FFA Association
  5. Leadership Training Units for Vocational Youth, Unit II, I. C. M. C.
  6. Robert's Rules of Order, The Interstate Printers
  7. FFA Student Handbook, National FFA Supply Service

B. Addresses of Reference Materials:

1. National FFA Supply Service
P. O. Box 15159
Alexandria, VA 22301

2. Indiana FFA Association
120 W. Market Street, 16th Floor
Indianapolis, IN 46204

3. The Interstate Printers
Danville, IL 61832

4. Indiana Curriculum Materials Center
TAW 200
Indiana State University
Terre Haute, IN 47809

OTHER REFERENCES

1. Plant Science Core Curriculum
Instructional Materials Laboratory
10 Industrial Education Building
University of Missouri
Columbia, MO 65201

2. Vocational Agriculture Education, Basic Core Curriculum
State Department of Vocational and Technical Education
Stillwater, OK

HANDOUTS:

1. "Speaker Evaluation Form"
2. "Sample Speech"
3. "Selecting The Topic"
4. "Developing The Topic"
5. "Speech Writing And Delivery"
6. "Judges Score Sheet"

TRANSPARENCY MASTERS:

1. "What is an Outline"
2. "Parts of an Outline"
3. "The Conclusion"

LESSON 1: EVALUATING AND PLANNING A PROGRAM OF ACTIVITIES.

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. List the divisions that are included in the chapter program of activities.
2. Describe specific functions of each division.
3. Describe how a program of activities can be developed.
4. Evaluate the effectiveness of the present program of activities.
5. Write new projects that could be included in the chapter program of activities.
6. Serve on an activities committee.

MOTIVATION:

Why does the chapter have a program of activities? Why not do away with it and handle activities as they are mentioned?

REFERENCES:

Official Manual, Future Farmers of America; National FFA Supply Service

Local Chapter Program of Activities

State Program of Activities

National Program of Activities

Programs of Activities from other FFA Chapters

FFA Advisor's Handbook, National FFA Supply Service

FFA Handbook, Indiana FFA Association

FFA Activity Guide, Indiana FFA Association

OUTLINE:

A. Divisions in the Program of Activities

1. Supervised Agricultural Occupation Experience
2. Cooperation
3. Community Service
4. Leadership
5. Earnings, Savings, and Investments
6. Conduct of Meetings
7. Scholarship
8. Recreation
9. Public Relations
10. Participation in State and National Activities
11. Alumni Relations

B. Reasons For Having a Program of Activities

1. Plan the specific chapter activities in advance.
2. Set chapter goals for the year.
3. To determine the ways and means by which the activities are performed.
4. Provide a plan for financial budgeting.
5. To divide the chapter activities so everyone can be involved.
6. To inform the school administration about activities in advance.
7. Each member can have a copy to use in reaching his personnal chapter goals.

C. Steps For Constructing a Program of Activities

1. Have evaluation of chapter activities.
2. Have executive committee appoint the program and activities committees.

3. Choose members according to their interests, if possible.

4. Vice-president should meet with each committee to assist them in formulating their phase of the program.

5. Use the programs of activities of the state association and national organization to aid in developing a program for the chapter.

6. Get ideas for activities from other chapters programs of activities.

7. Keep track of each committee's progress at regular chapter meetings and record the progress on a chart.

D. Functions of Each Division

1. S.O.E.

   a. To sponsor activities that increase the scope of the S.O.E. programs of the members.
   b. Conducts activities to improve the quality of the members S.O.E. programs.
   c. Promotes plant and/or animal loss prevention.
   d. Conducts activities to improve agricultural mechanics occupational experience of members.
   e. Recognition of outstanding S.O.E. programs.

2. Cooperation

   a. Sponsors cooperative purchasing and/or sales activities.
   b. Provides agricultural services for members.
   c. Conducts demonstrations in the community.
   d. Cooperates with other school organizations.
   e. Cooperates with other organizations and agencies in the community.
   f. Sponsors at least one activity to promote better understanding between residents within service area of school.
   g. Cooperates with other FFA chapters in conducting at least one activity.

3. Community Service

   a. Assists or sponsors an agricultural show.
   b. Presents educational programs before community.
   c. Assists charitable organizations and campaigns.
   d. Conducts a community safety program.
   e. Activities to help conserve natural resources or improve the environment.
   f. Assists school with a major activity (beautification campaigns).
   g. Other activities (parking cars, putting up signs for celebrations).

4. Leadership
    a. Provides members with leadership experience in public speaking.
    b. Provides members with training in parliamentary law and conducting meetings.
    c. Provides officer training.
    d. Assigns responsibilities for each member in the program of activities.
    e. Members meet leadership requirements for advanced degrees.
    f. Establish a chapter point system for achievement.

5. Earnings, Savings, and Investments
    a. Earn money to support activities.
    b. Chapter investments to broaden scope of chapter activities
    c. Conducts activities to encourage savings and stimulate investments among members

6. Conduct of Meetings
    a. Use of appropriate official ceremonies.
    b. To maintain a correct file of FFA materials
    c. Use of recommended procedures in keeping chapter records.
    d. Arrange a regularly scheduled meeting time.
    e. Invite an FFA officer above the chapter level to visit the chapter.
    f. Use nominating committee in officer elections
    g. Encourage graduates to retain their active FFA membership

7. Scholarship
    a. To sponsor activities to encourage scholarship among the members.
    b. To maintain a file of current information concerning agricultural careers, occupations, and educational opportunities.
    c. Provides a file of current information concerning scholarships and other financial assistance for post high school study.

8. Recreation
    a. Provides organized recreational activities.
    b. Provides organized social activities.

9. Public Relations
    a. Sponsors FFA awards and recognition programs.

   b. Uses the media to acquaint the public with the FFA organization.
   c. To provide a complimentary subscription to the national future farmer magazine.
   d. Conducts activities that acquaint the school faculty with the FFA.
   e. Secures movie illustrating an FFA activity.
   f. Participation in the FFA program.
   g. Conducts activities during FFA week.

10. State and National Activities

   a. Send representatives to state and national convention.
   b. Has successful candidates for advanced FFA degrees.
   c. Has candidates for an FFA office above the chapter level.
   d. Submit applications above the local chapter level for awards sponsored by the National FFA Foundation, Inc.
   e. Enters judging contests sponsored by the state or national organization.
   f. Participates in activities to promote international understanding.

11. Alumni Relations

   a. To conduct activities to inform active FFA members of the Alumni organization
   b. To conduct activities to re-involve former FFA members.
   c. To conduct a major activity with the affiliated alumni organization.

TEACHING LEARNING ACTIVITIES:

1. Use the motivation to open the discussion of this lesson.

2. Give to each student a copy of the chapter program of activities. Have the students list each division and write a description for the function of each.

3. Discuss the students descriptions and reach a class decision on the purpose of each division.

4. Assign reading from the Official Manual to give the students an idea of how to establish a program of activities.

5. Divide the class into groups. Assign each group a division or more from the chapter program of activities to evaluate. The evaluation should be made of each activity in the specific division.

6. A report from each group should be presented to allow the class to discuss the program activities.

7. After class discussion of each group's evaluation have each group view different divisions of the program and write at least one new project that could be included and omit projects that may not be worthwhile.

8. Have students choose a program division committee on which they would be willing to serve. Use the students' choices as a basis for the chapter president to make committee appointments.

SUGGESTED EVALUATION:

1. A written quiz over class discussion information.

2. Evaluation of the group activity and each group report.

LESSON 2: PUBLIC SPEAKING

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. List four ways public speaking will benefit a person.
2. Name two reasons for public speaking.
3. Distinguish between good speaking and bad speaking from examples.
4. List five factors to consider when evaluating someone as a speaker.
5. List the five general intents of a speech.
6. Read a speech and identify the introduction, body, and conclusion.
7. Develop ideas for a speech.
8. Name four reasons for outlining a speech.
9. Prepare and deliver a three to eight minute speech relating to agribusiness.

MOTIVATION:

Invite a State FFA Officer to visit the class and present a speech. Make the lesson into a speech contest for the class with the best speaker to be used in future competition.

REFERENCES:

Official Manual, Future Farmers of America; National FFA Supply Service

FFA Advisor's Handbook, National FFA Supply Service

FFA Activity Guide, Indiana FFA Association

FFA Handbook, Indiana FFA Association

Leadership Training Units for Vocational Youth, Unit II, I.C.M.C

Handouts: "Speaker Evaluation Form"
"Sample Speech"
"Selecting The Topic"
"Developing The Topic"
"Speech Writing And Delivery"
"Judges Score Sheet"

Transparencies: "What is an Outline"
"Parts of an Outline"
"The Conclusion"

OUTLINE:

A. Benefits of Public Speaking

1. Can build friendship.
2. Allows for exchange of information.
3. To give or ask for orders.
4. As a source of entertainment.
5. To allow a person to display wit or intelligence.

B. Reasons for Public Speaking

1. To express a person's ideas.
2. To communicate to others.

C. Evaluation of a Speech

1. Is it audience centered.
2. Does it progress from introduction to conclusion.
3. Is the speaker telling the truth.
4. Does the speaker gain respect of the audience.
5. Is the audience listening to the speech or the speaker.

D. Ways to Improve Speaking

1. Thorough research

2. Practice
3. Accuracy in presentation
4. Accept constructive criticism
5. Know the subject
6. Be enthusiastic and pleasant
7. Use a calm and steady rate of delivery

E. The General Intent of a Speech

1. To inform
2. Induce belief
3. Move the audience to take action
4. To inspire
5. To entertain

F. Develop Ideas By:

1. Starting with personnal knowledge
2. Research of available references.
3. Recording the speech material

G. Outlining a Speech

1. Reveals its strengths and weaknesses.
2. Aide in organization and development of ideas
3. Reveals the proportion of the speech.
4. To be used to save time.

H. Ways of Developing Proper Delivery

1. Stand in front of mirror
2. Use a tape recorder
3. Present speech to someone

I. Ways of Making a Good First Impression

1. Step up to lectern briskly and confidently
2. Stand behind lectern in a comfortable but erect position
3. Be clearly heard with pleasant volume
4. Let all important actions, objects, and aids be clearly seen
5. Gain and hold audience attention
6. Recognize that some fear is normal and do not get upset

J. Developing and Adding Meaning to Delivery

1. Eye contact
2. Gestures
    a. Hand
    b. Facial
3. Posture
4. Movement
5. Voice control

TEACHING LEARNING ACTIVITIES:

1. Ask students to state why they might think public speaking is important. Discuss their answers.
2. Use the Unit II Leadership Training Units for Vocational Youth as a part of the lesson to develop the students' communication skills.
3. Ask students what they expect from a good speaker? Next, ask them what are some things that should be considered when giving a speech. The teacher should be sure to include the basic speech format of introduction, main body, and conclusion; proper presentation procedure; and general mannerisms.
4. Give students the speaker evaluation assignment sheet and have them fill out and return.

5. Select individual evaluation sheets for class discussion.

6. Hand out the assignment sheet for speech reading.

7. Discuss with the class why it is important to develop your ideas, find the references, and develop a complete outline. Show the four transparencies.

8. Use the assignment sheet and allow the students to select a speech topic. The teacher should review the topic and make recommendations on further research.

9. After the topic has been selected and the research of the topic is complete have the students write a sentence outline. (See "Write Sentence Outline on Selected Topic").

10. Upon completion of the outline instruct students to write a three to eight minute speech and prepare to present it.

SUGGESTED EVALUATION:

1. Quiz students over general speech structure and methods of presentation.

2. Evaluate activities performed in Unit II of the Leadership Training Units for Vocational Youth.

3. Grade the various student assignments.

4. Evaluate each student's speech.

Name ____________________

SPEAKER EVALUATION FORM

Rate the skill of a speaker by using the questions below. The speaker should be someone speaking in your community. If a speaker is not possible, refer to the television or radio. Listen to the speech and then fill out the form and turn in to the instructor.

A. Speaker's name and/or position. ____________________

B. Who was the audience? ____________________

C. What were the goals of the speaker?

1) inform

2) induce belief

3) move to action

4) inspire

5) entertain

D. Did the speaker use any poor speaking habits? ____________________

1) Careless preparation _____

2) Boastfulness _____

3) Unsupported facts _____

4) Dull unchanging voice _____

5) Spoke to rapidly _____

6) Fault-finding _____

E. Was the speech directed to the audience? ____________________

F. Did you agree with the speaker? ____________________

G. Write a short paragraph explaining your impression of the speaker and his speech. (Use back of sheet)

SAMPLE SPEECH

Read the following speech. Identify the introduction, body, and conclusion. Write a short discussion of how well you believe the three parts were written. Return the assignment to the instructor for his evaluation.

AGRICULTURE'S NEW GENERATION

Dee W. James
Clay Center FFA Chapter
Clay Center Community High School
Clay Center, Kansas

What if no one wanted to be a farmer anymore?

What if no one wanted to work 70 or 80 hour weeks?

What if no one wanted to battle droughts, floods, hail and frost?

What if all farmers just quit?

We've lost three million farmers in the last 25 years. . . . and every day we lose 70 more . . . so fewer and fewer farmers must grow more and more food.

Who will meet this enormous challenge?

A new generation of farmers . . . armed with the vast knowledge and technical skills of today's farmer . . . the new generation will continue to make breakthroughs in soil sciences, chemistry, animal husbandry . . . and others.

Today, one American farmer feeds 56 other Americans . . . tomorrow he may have to feed twice that number. It could be the biggest challenge America will face in the next 25 years. America and the American Farmer- - we need each other.

Last December, Farmland Industries co-sponsored a John Denver special where this message was heard and viewed by millions of people all over this country. Their purpose was to educate America on the importance of agriculture. Booker T. Washington once said, "No race can prosper till it learns that there is as much dignity in tilling a field, as in writing a poem." I know of no better method of teaching the importance and dignity of agriculture than through vocational agriculture, and I know of no better organization that can put this knowledge to use than the Future Farmers of America--agriculture's new generation. Former President Richard Nixon, addressing the State FFA

-- MORE --

Presidents at the White House said, "I know of no other organization more qualified to feed America, and lead America, than the Future Farmers of America." Over half a million FFA members across this nation are faced with this challenge of feeding and leading America, and already we are proving our worthiness for such a demand.

Vocational agricultural training and membership in the FFA can be the most worthwhile experience of one's high school career. It is training that will be used forever. This is not to say we should abandon or even weaken the basics of education, but this practical knowledge in agriculture will supplement our education and provide us with an understanding of agriculture that is essential in our society today.

Agriculture seems to be misunderstood and taken for granted. We need to educate more people by telling the story of agriculture and how it meets the enormous challenge of feeding millions of persons. Although many FFA members do engage in production agriculture, let us not overlook the importance of agricultural training in other occupational fields. Virtually everyone comes in contact with some form of agriculture, unless of course, you have never eaten! One American farmer feeds more people than any other farmer in the world, fifty-six. And the population of the world is still rapidly increasing each year, while at the same time farm population is decreasing. Farm population has dropped from 8.6% of the total U. S. population in 1960, to an almost even 4% today. But I don't think there is much need for alarm, for even with the declining number of farmers, production levels of most agricultural commodities are meeting and in some cases exceeding the demand. But how long will this continue? Who knows? One thing is certain however: researchers, scientists, and other agricultural related specialists must continue in their constant search to improve the capabilities of American agriculture.

-- MORE --

I feel our organization is doing its part in keeping up with demands for improvement. I'll bet Carlton Patton would be amazed to hear the description of a farming program that goes as follows: 320 acres dryland and irrigated farmland owned and an additional 480 acres rented, a 70 head cow herd which yielded a 98% calf crop in a 30-day period, and the feeding of several hundred hogs each year. Yet this is a description of a program developed by a man like Carlton Patton. However, Mr. Patton was the first Star Farmer of America and Dan Worcester from the Hill City, Kansas, chapter was the forty-seventh. Dan's operation is only one example of the programs awarded the American Farmer degree. I'm sure each of the occupational experience programs of the American Farmer degree recipients could be looked upon with equal impressiveness. Programs that are worthy of the American Farmer degree are not developed by chance--they are made through hard work and determination.

The American Farmer degree is obtained only by completing the requirements for the four degrees of membership. The last two sentences of the advisor's part in the ceremony for receiving Greenhands, the first level of membership, reads like this:

> You have attained your first degree, but let me remind you that the Chapter Degree pin, the State Degree charm, and the American Degree key await those who earn them. May you work hard and advance in rank.

This type of goal-setting standard will help insure our ability to meet the enormous challenge that is associated with agriculture. World attention continues to focus more and more on the importance of agriculture. For if we had to, we could survive without oil, but no one can survive without agriculture. Food, as some people say, could be the greatest weapon a country can have. Daniel Webster once said,

> Let us not forget that the cultivation of the earth is the most important labor of man. Unstable is the future of that country which has lost its taste for agriculture. If there is one lesson in history which is unmistakable, it is that national strength lies very near the soil.

-- MORE --

We, today, need this same type of leadership and belief in agriculture that Daniel Webster displayed in his time. Again FFA members are meeting this challenge. I feel John F. Kennedy was speaking to us when he said, "It is time for a new generation of leadership, to cope with the problems and new opportunities, for there is a new world to be won." Past Future Farmers and vocational agricultural students are continuing their leadership abilities for the betterment of agriculture. Don Staheli, President of Allied Mills and past National President of the FFA is one such leader. Orion Samuelson, past FFA member from Wisconsin, speaks out for agriculture every day in one of the largest cities in the world, Chicago, through WGN radio and television. Another past FFA member raised in the agricultural South served in his first office as secretary of his chapter in Plains, Georgia. Yes this same man was inaugurated, January 20th, as the 38th President of the United States, Jimmy Carter.

We need this kind of dedicated commitment in serving agriculture and our country. I have a great deal of faith and confidence that agriculture will continue to meet the demands of the world. I also firmly believe in the role of the Future Farmers of America and vocational agriculture training, to help supply the manpower and leadership that will "stand solid for our part in that inspiring task." Furthermore, I feel that agricultural development, like the development of all of the other arts, will hold true by proving--"The best is yet to come." As you can see in more ways than one, FFA members are proving to be--agriculture's new generation.

-- END --

SELECTING THE TOPIC

Select an Agribusiness related topic on which you would like to speak. Conduct as much research as possible on the topic. After completing the research with the instructor about additional information. Review what has been found. Record your research information below.

DEVELOPING THE OUTLINE

Following the research, you should outline your speech in order to develop meaning and clarification. By using the information you have collected, write a sentence outline. Have the instructor review it and discuss means of improvement.

SPEECH WRITING AND DELIVERY

Write a three to eight minute speech using the sentence outline. Have the instructor evaluate your manuscript. Study the manuscript and present it. The space provided below may be used for writing the speech.

JUDGES' SCORE SHEET

State Public Speaking Contest
Future Farmers of America

Part I. For Scoring Content and Composition

Items to Score	Points Allowed	Points awarded contestants 1	2	3	4	5	6	7	8	9	10	11	12
Content of the manuscript	200												
Composition of the manuscript	100												
Score on written production	300												

Part II. For Scoring Delivery of the Production

Items to Score	Points Allowed	Points awarded contestants 1	2	3	4	5	6	7	8	9	10	11	12
Voice	100												
Stage presence	100												
Power of expression	200												
Response to questions	200												
General effect	100												
Score on delivery	700												

Part III. For Computing the Results of the Contest

Items to Score	Points Allowed	Points awarded contestants											
		1	2	3	4	5	6	7	8	9	10	11	12
Score on written production	300												
Score on delivery	700												
TOTALS	1,000												
*Less overtime deductions for each minute or major fraction	20												
*Less undertime deductions for each minute or major fraction	20												
GRAND TOTALS													

*From Timekeeper's record
For explanation of score sheet items, see next page.

WHAT IS AN OUTLINE?

I. INTRODUCTION
  1. INTEREST GAINER
  2. ESTABLISH A RELATIONSHIP

II. MAIN IDEA
  1. REASON FOR GIVING TALK
  2. CENTRAL THOUGHT

III. BODY
  1. FIRST MAIN POINT
    A. SUBHEADING—DEVELOPMENT OF POINT
      a. SUPPORTING IDEA
      b. ANY FURTHER SUPPORT
    B. SUBHEADING
  2. SECOND MAIN POINT
    A. SUBHEADING
      a.
      b.
    B.

IV. CONCLUSION
  1. SUMMARY AND RESTATE THE IDEA
  2. A FINAL PUNCH LINE

PARTS OF AN OUTLINE

I.	INTRODUCTION:	1. AROUSES INTEREST
		2. INDICATES YOUR APPRECIATION OF THE AUDIENCE
II.	MAIN IDEA:	1. LETS THE AUDIENCE KNOW WHAT THEY ARE TO HEAR
		2. PREPARES THEM
III.	BODY:	1. DEVELOPS THE MAIN IDEA
IV.	CONCLUSION:	1. SUMMARIZES AND REVIEWS
		2. WILL URGE ACTION OR GAIN RESPECT FOR IDEAS

THE CONCLUSION

THE PURPOSES OF A CONCLUSION.

I. INSPIRES ACTION OR RESPECT FOR IDEAS

II. CLINCHES ARGUMENTS

III. TO GIVE A FEELING OF FINALITY TO TALK

LESSON 3: REVIEW PARLIAMENTARY PROCEDURE

OBJECTIVES:

At the completion of this lesson the students will be able to:

1. Use correct parliamentary procedure at meetings.
2. Participate in business meetings.
3. Conduct a regular FFA chapter meeting.

MOTIVATION:

Choose a student to come up to the front. Without telling the class what is about to happen put a motion on the floor. Ask the student at the front if the motion was stated correctly. Ask another student if it was stated correctly. Ammend the motion incorrectly and allow the student at the front to handle the ammendment. Ask other students if the ammendment was correct and was handled correctly. Ask a student what vote is required for a motion to suspend the rules. Write on the chalk board the question, Why is parliamentary procedure needed for meetings? Have students write their answers.

REFERENCES:

Roberts Rules of Order, The Interstate Printers

Official Manual, Future Farmers of America, National FFA Supply Service

Handout: "Parliamentary Procedure Check List"

OUTLINE:

A. Importance of Parliamentary Procedure
    1. To organize the meeting.
    2. To let everyone be heard.
    3. To save time.
    4. To maintain order.

B. Main Motion

1. Main idea before the meeting.
2. Only one main motion before the meeting.

C. Subsidiary Motions

1. Lay on table.
2. Previous question.
3. Refer to committee.
4. Amend.
5. Postpone indefinitely.

D. Incidental Motions

1. Point of order
2. Appeal
3. Suspend rules
4. Withdraw a motion.
5. Parliamentary inquiry
6. Object to consider
7. Call for division of the house
8. Call for a division of a question

E. Privileged Motions

1. Fix time
2. To adjourn
3. To take a recess
4. Question of privilege
5. Call for orders of day

TEACHING LEARNING ACTIVITIES:

1. After using the motivation hand out the Parliamentary Procedure Check List for students to complete. Allow students to use available references to aid them in completing the assignment.

2. Each day before practicing parliamentary procedure hand out a new Parliamentary Procedure Check List to test students on their memory of the procedures used for each motion.

3. Review and discuss the motions on the check list mentioning specific procedures for each.

4. Allow students to study each motion and select students to correctly use a selected type of motion.

5. Select at random different students to take turns as acting chairman. The teacher should submit motions to be acted upon by each acting chairman. Have the other students evaluate each acting chairman's procedure. Allow every student to be an acting chairman.

6. Divide class into small parliamentary procedure teams. Allow the teams some time to practice. Hold a class contest with prepared motions. If possible use another teacher to help judge the contest.

7. If a contest is impossible have each team go before the rest of the class and go through the procedures of a chapter meeting. Allow the other team(s) to give a written evaluation of the performing team's procedure.

SUGGESTED EVALUATION:

1. Grade the students' answers on the check list.

2. Evaluate the actions of the chairman.

3. Assign grades to the students' written evaluations of the selected chairman and selected chapter meeting team.

4. Evaluate procedure of members of each chapter meeting team.

PARLIAMENTARY PROCEDURE CHECK LIST

	Can it be debated?	Can it be amended?	What vote is usually required?	Is a second required?	Can subsidiary motions be applied to it?	Is it in order when another has the floor?
SUBSIDIARY MOTIONS						
To lay on the table						
To call for the previous question						
To limit or extend time for debate						
To postpone definitely (to a certain time)						
To commit or refer						
To amend						
To postpone indefinitely						
INCIDENTAL MOTIONS						
To raise a point of order						
To appeal from the decision of the chair						
To suspend the rules						
To object to the consideration of a question						
To divide the question						
To call for a division						
To nominate						
To make a request growing out of pending business						
PRIVILEGED MOTIONS						
To fix the time to which to adjourn						
To adjourn						
To take a recess						
To raise a question of privilege						
To call for the order of the day						
UNCLASSIFIED MOTIONS						
To take from the table						
To reconsider						
To rescind						
To ratify						
MAIN MOTIONS						

Courtesy of the Instructional Materials Laboratory
10 Industrial Education Building
University of Missouri
Columbia, Missouri 65201

UNIT III

CAREERS
Introduction to the Unit

The emphasis of any vocational program is placed on career development or training. On-the-job training or occupational placement can be better accomplished if the students that are being placed have skills and knowledge in how to go about gaining employment.

The intent of this unit is to prepare the student for seeking and gaining employment. This preparation is to be accomplished by first taking a look at the career and finding out about available jobs, second by preparing personal information and an interview format, third by practicing personal communication and math skills, and last by taking a look at the personality and human relations involved in an occupation.

LESSONS:

1. Reconsidering Career Plans
2. Finding Out About Available Jobs
3. Gaining Employment
4. Selling Yourself Through Communication
5. Agribusiness Math
6. Personality Development
7. Agribusiness Human Relations

OBJECTIVES:

Upon completion of this unit the student will be able to:

1. Select a career that is interesting.
2. Find out the employment situation for a given job area.
3. Prepare written material to be used to gain employment.
4. Participate in a job interview.
5. Communicate with others in written and spoken form.

6. Work basic mathematical problems.
7. Develop good personality habits.
8. Avoid problems and improve human relations while on the job.

MOTIVATION:

Ask the class, "Who wants a job?" Discuss what they need to know to apply for and get accepted to an occupation.

TEACHING REFERENCES:

A. General References:
    1. Exploring Agriculture; Prentice Hall, Inc.
    2. "Personal Inventory", Agribusiness I
    3. Arithmetic in Agriculture, The Interstate Printers
    4. Shop Mathematics, Benziger Bruce and Glencoe, Inc.
    5. Leadership Training Units for Vocational Youth, I.C.M.C.

B. Addresses for Reference Materials:

1. Prentice Hall, Inc.
Englewood Cliffs, New Jersey 07632

2. The Interstate Printers and Publishers, Inc.
Danville, IL

3. Benziger Bruce and Glencoe, Inc.
8701 Wilshire Boulevard
Beverly Hills, CA 90211

4. Indiana Curriculum Materials Center
TAW 200
Indiana State University
Terre Haute, Indiana 47809

OTHER REFERENCES

1. Core II, Plant Science, Instructional Material Laboratory, University of Missouri-Columbia

Department of Practical Arts and Vocational Technical Education
and Career and Adult Education
State Department of Elementary and Secondary Education
Jefferson City, Missouri

2. Vocational Agriculture Education, Basic Core Curriculum
State Department of Vocational and Technical Education
Stillwater, Oklahoma

HANDOUTS:

1. "Collecting Career Information"
2. "Information for Job Interview"
3. "Agribusiness Math Problems"
4. "Worker Situation"

TRANSPARENCY MASTERS:

1. "Sample Letter of Application"

LESSON 1: RECONSIDERING CAREER PLANS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Re-evaluate the career decision from the previous year.
2. List things to consider when choosing a career.
3. Survey the community and area for opportunities in the chosen career.
4. Select a career and collect information concerning qualifications, expected advancement, salary, and the future outlook.

MOTIVATION:

1. Have each student select a career and select information about the career. Write each student's career on a display card for their desk. Have each student or group of students answer questions from the rest of the class about their career area. Give each student a list of sample questions to use.
2. After discovering which career areas in which the students show the most interest have guest speakers from those areas in for class discussion.

5

REFERENCES:

Exploring Agriculture, Prentice Hall, Inc.

Other career pamphlets and materials

Handouts: "Career Selection"

Transparency Master: "A Path to a Choice"

OUTLINE:

A. Things to Consider

   1. Personal interests, abilities, and other individual characteristics.

2. Job requirements, working conditions, other job characteristics.
3. Match personal interests with the job characteristics.

B. Make Career Plans

1. Learn about the job and how advancement is accomplished.
2. Prepare plans for developing skills and other characteristics needed for occupational success.

C. Community Survey - Locate the Occupation

1. Use personnal knowledge of jobs.
2. Use phone directory to find certain businesses.
3. Look in newspaper advertisements.
4. Use magazines that represent your area.
5. View area displays at fairs and special shows.
6. Ask other people in the community.

D. Community Survey - Interview Workers in the Chosen Occupation

TEACHING LEARNING ACTIVITIES:

1. After activity #1 discussion have the students get their personal inventory sheets from the previous year. Discuss with the students what particular things they might consider when selecting a career.
2. Ask the students what they should consider in making plans for a career.
3. Have the students re-evaluate their personnal inventory and decide on their career interest. Have the students return their personal inventory sheets.
4. Hand out the career selection sheet and review the assignment with the class.
5. Allow class time for students to use available classroom references to obtain career information.
6. At the completion of the assignments use the lesson motivation.

SUGGESTED EVALUATION:

1. Quiz over career information obtained during the motivation exercise. Have each student write a sample quiz question about their assignments.

COLLECTING CAREER INFORMATION

Select a career that you would like to pursue after graduation. It is very important that you give a good deal of thought to what career you want to pursue upon completion of high school. Much time, thought, and preparation is needed to select a career that more than likely will become a way of life for you.

1. Selected Career: ______________________________
2. Level within occupation: ______________________________
3. What educational training is needed? ______________________
4. Is the means for advancement provided? ____________________
5. What are the working conditions? __________________________
6. What procedures are needed to obtain the job? ______________
7. What are the expected earnings and benefits? ______________
8. What are your reasons for selecting this particular career?

9. How has the career affected your attitude about the career?

LESSON 2: FINDING OUT ABOUT AVAILABLE JOBS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List sources of information about jobs.
2. Develop a plan for finding a job.

MOTIVATION:

Ask the class the following questions. Who has worked away from home for wages? How did you find your job?

REFERENCES:

Newspapers

Telephone Books

Other Business Advertisements and pamphlets

Career Texts

OUTLINE:

A. Sources of Information
    1. Friends and relatives
    2. Former employers
    3. Personal calls
    4. Placement bureaus
    5. Job surveys

TEACHING LEARNING ACTIVITIES:

1. Ask the students what are some common sources for finding a job. Have these listed on the chalk board. Add any additional sources that students might overlook. (See outline)

2. Discuss the sources. Have students list advantages and disadvantages of each source.

3. Divide the class into groups. Have each group draw for one of the job sources that were listed. Each group should prepare a presentation on how to use each source of information. Build presentation from advantages and disadvantages.

4. Assign each student to develop a plan for locating their first (or next) job.

SUGGESTED EVALUATION:

1. Grade students on their group participation.

2. Evaluate each student's plan for locating a job.

LESSON 3: GAINING EMPLOYMENT

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Develop a resume
2. Fill out an application form
3. Write a letter of application
4. Participate in job interviews

MOTIVATION:

Invite a businessman to come into the class. Ask for a presentation on what is expected in a job interview. Select a student the day before to prepare an interview with the guest. Discuss the interview with the class.

REFERENCES:

A Job Application Form (school or local business)

Personal Inventory, Agribusiness I

Handout: "Information for Job Interview"

Transparency Master: "Sample Letter of Application"

OUTLINE:

A. Develop a Resume

   1. Develop a general written statement.

      a. General philosophy (example - "Learning to do, Doing to Learn, Earning to Live, Living to Serve") base statements on this thought.
      b. General basic experience.
      c. Family information.
      d. Class and organization related activities.

2. General information
    a. Name
    b. Date of birth
    c. Place of birth
    d. Marital status
    e. Church preference (optional)
    f. Military status
    g. Home address
    h. High school activities
    i. Equipment that can be used
    j. Other skills
    k. Work experience

3. References
    a. Character references
    b. Previous employers

B. Personal Inventory

1. Determine your career interests

2. Determine your abilities

3. Determine your interests

4. Determine your past experience

C. Letter of Application (See Transparency Master)

1. State your interest in the job

2. Describe your qualifications
    a. Educational
    b. Experience

3. Description of other hobbies and activities

D. Things an Employer May Ask

1. What do you know about the company?

2. What are your future plans?

3. What jobs have you held? How were they obtained and why did you leave?

4. What extra curricular activities did you participate in?

5. What interests you about the products we sell?

6. Why do you think you would like to work for this company?

7. What was your rank in your high school class?

8. Do you like regular hours of work?

9. Do you have any special abilities or skills?

10. Would you complain about working overtime?

11. Do you think the work here at this business would have any disadvantages?

12. Have you worked with other jobs that would help with the work here?

13. Do you have any hobbies?

14. What is your favorite recreation?

15. Were you active in sports while in high school?

16. Could you take orders from other workers?

17. Are you considering this as a temporary or permanent job?

18. Do you think that high school grades should be considered in relation to a job?

19. Do you think you have good general background for this job?

20. Do you prefer working with others or by yourself?

TEACHING LEARNING ACTIVITIES:

1. After the interview point out some items that might have helped the student during the interview. Items such as:
   a. Resume
   b. A previous letter of application
   c. Prepared list of information and questions
   d. Check list of physical characteristics
   e. What should follow the interview?
   (Letter of appreciation.)

2. Ask students to develop a resume. Use the outline information to discuss what should be placed in a resume.

3. Have the students take a personal inventory to determine their career interests from experience, abilities and interests.

4. Show and discuss with the students the "Sample Letter of Application". Have each student write a letter of application when given specific information.

5. Ask the students what are some things they need to consider in preparing for an interview.

   a. What questions will the interviewer ask?
   b. What type of dress and manners should be considered?

   To aid in discussion see "D" in the outline and hand out the physical characteristics check list.

6. Divide class into interviewers and interviewees. Provide interviewers with questions for a specific job. Provide interviewees with basic information of the job. Have interviewers evaluate the interviewee. Then have the students switch their roles and move the students so that no student is interviewed by the same student that they had previously interviewed.

7. Hand out "Job Interview Information" assignment and have students complete by interviewing. The teacher should arrange certain businesses and the school administrators to be the interviewers before this assignment is made.

SUGGESTED EVALUATION:

1. Evaluate student assignments.

2. Assign grades based on student interview ratings.

III-14H

Name ____________________________

INFORMATION FOR JOB INTERVIEW

Gain the following job interview information.

1. Selected career
2. Job title
3. Description of what the worker does.
4. What equipment or tools is used.
5. Type of education the job requires:
   High School ____
   Technical School ____
   College ____
   Other ____
6. What other qualifications are required.
   Personality
   Mental
   Physical
7. This job is found in what type of business?
8. List other related jobs.
9. What personnal interests does this job satisfy?
10. What are the hours and working conditions?
11. What are the opportunities for advancement?
12. What is the basis used to promote employees?
13. Is this job employment rate expanding? (hiring more in the future)
14. What abilities of yours are related to this job?
15. What equipment will the employee need to purchase?
16. What are the most common mistakes made by employees in performing the job?
17. What are the expected earnings and benefits from the job?

SAMPLE LETTER OF APPLICATION

_________ High School
Vocational Agriculture Department

RR #
City, State Zip Code

Date

Mr. ______________
Business Name
R.R. or Street
City, State Zip Code

Mr. ______________:

Please consider this my application for the position of grain elevator worker with your business.

My personnal data are briefly: 16 years of age, sophomore in high school in vocational agribusiness, with farm experience. I am presently in the upper _____ of my class and have an overall high school grade average of a "C."

I have had three months of experience in a similar occupation and feel confident that I can do the job.

I am sincerely interested in a career in your business and would appreciate an interview with you at your earliest convenience to acquaint you with my experience and explain to you why I am interested in the position.

Sincerely,

LESSON 4: SELLING YOURSELF THROUGH COMMUNICATION

OBJECTIVE:

At the completion of the lesson the student will be able to:

1. Demonstrate proper communication procedures for given situations.
2. Write a grammatically correct report on an agricultural related subject.
3. Present a report on an agricultural related subject.

MOTIVATION:

Place a divider in the center of the desk. Have two sets of four blocks with either teacher, principle, student, or employer written on each. Ask two students to volunteer to prove their communication skills. Arrange the blocks of one of the students in a certain pattern. Have the student with the arranged blocks (student 1) tell the other student how to arrange his blocks in the same manner. The student that has to arrange his blocks is not allowed to speak.

Do the same procedure with two different students and allow the student arranging the blocks to speak.

Ask the class what they observed. Direct the class to discussion of the importance of listening and of accurate communication.

REFERENCES:

Any available language or communications texts

OUTLINE:

A. Communication by Conversation
   1. Show respect and consideration for others.
   2. Listen to what others say.
   3. Contribute to the conversation.

B. Communication by Letters

1. Identify purpose of letter.
2. List the ideas and facts to accomplish the letter's purpose.
3. Organize letter information.

C. Communication on the Telephone

1. Making calls.
    a. Identify yourself.
    b. State reason for calling.
2. Answering the phone.
    a. Answer courteously and state name.
    b. Take message for person unable to answer phone by asking name of caller and taking message.
3. Long distance calls.
    a. Direct dialing.
    b. Give your name to answering party and state that the call is long distance.

D. Communication Through Body Language

1. Gives reactions of boredom, surprise, sincerity, indifference and other feelings.
2. Can be used to measure reactions to conversations, speeches, demonstrations, and written messages.

E. Writing a Report

1. Introduction section - briefly stating what the report is about.
2. Main body - explanation of the information obtained.
3. Conclusion - the writer's reaction to the report and a recap of the main body.

F. Present a Report

1. Introduce the report.
2. Use visuals to add to presentation of graphs or other information or pictures.

3. Give conclusion of the report with general comments on the information in the report.

TEACHING LEARNING ACTIVITIES:

1. Use the motivation and discuss the importance of communication.
2. Provide students with different situations such as basic introduction or telephone communications to practice communication techniques.
3. Provide students with information for a letter and have each student write the letter.
4. Allow students to select a magazine article or other source of information on an agricultural topic and write a report.
5. Students should use the written reports to present to the class.

SUGGESTED EVALUATION:

1. Evaluate students' communication techniques.
2. Grade the written letter.
3. Evaluate the written reports and each report presentation.

LESSON 5: AGRIBUSINESS CALCULATIONS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Add, subract, multiply and divide with common fractions.
2. Write a personal check.
3. Write a bill of sale.
4. Operate a cash register.
5. Estimate and add on state sales tax.
6. Figure change returned for an over-payment.

MOTIVATION:

The teachers should explain that a knowledge of use of fractions is important in learning how to determine ratios and percentages that are commonly used in different areas of Agribusiness. A basic knowledge of math is required in any job but particularly in the areas of agribusiness.

REFERENCES:

Arithmetic in Agriculture, The Interstate Printers

Shop Mathematics, Benziger Bruce and Glencoe, Inc.

Handout: "Agribusiness Math Problems"

OUTLINE:

A. Use of Math in Mechanics:
   1. Measurements for accuracy.
   2. Determining costs and prices.
   3. Figuring bills of materials and bills of sale.
   4. Taking inventory of materials.
   5. Keeping work records.

B. Use of Math in Production:
   1. Record keeping.
   2. Balancing feed rations.
   3. Determining planting, fertilization and pesticide rates.

4. Adjusting equipment.
5. Finding the best market.
6. Determine a good buy.

C. Use of Math in Supplies and Services
   1. Accounting
   2. Writing bill of sale.
   3. Determining costs and prices.
   4. Inventory of materials.
   5. Work records.
   6. Testing the product accurately.

D. Use of Math in Horticulture
   1. Record keeping.
   2. Land measurements.
   3. Weights and measure of plant materials.
   4. Building and ventilation estimates.
   5. Bills of sale.
   6. Determining costs and prices.

E. Use of Math in Natural Resources
   1. Land surveying.
   2. Scientific measurements.
   3. Record keeping.
   4. Determining costs and prices.
   5. Structure designs.

F. Use of Math in Forestry

1. Estimating standing timber.
2. Determining board feet.
3. Measuring cuts at the mill.
4. Determine tree spacings at planting.
5. Figuring bill of sale.
6. Determining costs and prices.
7. Land measurement.

TEACHING LEARNING ACTIVITIES:

1. Write the six agribusiness areas on the board leaving room for listing ways each area uses math. Ask students how math is important to these different occupational areas. Have students write in their suggestions on the board.
2. Ask students why fractions are basic to many math skills. Explain that fractions are the basis for percentages and ratios and are important for measurement use.
3. Hand out problems for students to solve during the class period. Demonstrate to the class how to work with fractions then allow them to work with the sample problems.
4. Use cancelled checks to show students how checks are written. Draw a diagram of the check and explain each part. Point out why it is important to include each part of the check.
5. Have students bring in bills of sale. Make a ditto of sample bill of sale and provide each student with a sample list of items. Have the students fill out the bill of sale.
6. Review state sales tax rules with the class. Give a sample problem for students to figure in sales tax.
7. Have students figure amounts of change for an over-payment.
8. Provide a cash register for students to practice operating. Note: Possibly borrow one from administration office.
9. Take a field trip to business to observe sales transactions. Arrange with owner to have demonstration of cash register operation, bookkeeping information, and demonstration of a sales transaction including the cashing of a check.

SUGGESTED EVALUATION:

1. Assign grades to student activities.
2. Test students on math and sales transactions.

AGRIBUSINESS MATH PROBLEMS

1. How many stalls can be placed in a barn 30 foot long. if each stall takes up 8 3/4 ft? The left over space at the end will be used for feed storage.

2. If a steer gains 2 1/4 pounds per day, how much total weight will it have gained at weaning or 220 days?

3. A man plans to sow wheat on 16 acres of land. How many bushels will he need if he sows 1 1/4 bushels per acre?

4. Dogwood trees sell for $250 per 100. How much will 72 dogwood trees cost.

5. If a can of herbicide contains 5 gallons, how many gallons are in 2/3 of a can?

6. If one flat of petunias is sold at $3.50, how much are 3 1/2 flats sold for?

7. If a tractor averages 1/2 hour per gallon of fuel, how many hours will it take to burn up 8 1/2 gallons?

8. If a hen lays eggs 260 days out of every 365 days then what fraction is this of a total year?

9. If the diameter of a grain bin is 15 1/2 feet and it is 10 feet high, what is its volume? How many bushels of corn can it hold? (1.25 bu = 1 cu ft)

10. If soybean seed priced at $15 per bushel is on sale at 1/4 off, what is the price per bushel?

LESSON 6: PERSONALITY DEVELOPMENT

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Describe what is needed to have a good physical appearance.
2. Evaluate voice qualities of speakers.
3. List personality habits that are beneficial to employment.

MOTIVATION:

Use a video tape recorder or a tape recorder and record a well known news commentator (locally known). Provide scripts for students to read as the local news man. Scripts can be obtained by writing for a copy of the Farm Broadcasters Letter, Layne Beaty, Chief Radio and T.V. Director Office of Communications, U.S.D.A., Washington D. C. 20250. Point out to students that anybody can change their personality with very little effort.

REFERENCES:

Leadership Training Units for Vocational Youth, I.C.M.C.

OUTLINE:

A. Physical Appearance
    1. Clean hands and fingernails
    2. Brushed teeth
    3. Shaven
    4. Clean ears, neck, arms, hair
    5. Hair cut neatly
    6. Clean, neat clothes and shoes

B. Voice Qualities

1. Distinctness
2. Loudness
3. Emphasizing words or phrases
4. Pitch
5. Speed
6. Pleasing manner
7. Sincerity
8. Does not stammer or hesitate
9. Friendly tone
10. Speaks with hands

C. Personality Habits Beneficial to Employment

1. Develop proper work habits
   a. Accuracy of work
   b. Careful
   c. Cooperate with others
   d. Alert
   e. Conscientious
   f. Safe
   g. Get the job done
   h. Enjoy work
   i. Work efficiently
   j. Accept responsibility
   k. Help others
   l. Accept only realistic work loads
   m. Finish work on time
2. Being loyal
3. Cooperative
4. Decisive
5. Dependable
6. Punctual
7. Honest

8. Showing good sportsmanship
9. Budgeting and managing time wisely
10. Establishing priorities

TEACHING LEARNING ACTIVITIES:

1. Discuss with class what items of physical appearance are important for employment.
2. Have students make a list of voice characteristics that are considered important. Use information from outline to aid in compiling the list.
3. Have students use the list to evaluate different class members' reading or reciting the FFA Creed.
4. Class members may want to evaluate themselves on tape.
5. Assign Unit 7 of the Leadership Training Units for Vocational Youth. Explain to the class that to become a success in a career requires the development of the group leader potential in each of us.
6. Using the outline as a guide, discuss with the class certain personality habits that are beneficial to employment.

SUGGESTED EVALUATION:

1. Evaluate activities performed from the exercises in the Leadership Training Units for Vocational Youth.
2. Give a written quiz on information discussed during the lesson.

LESSON 7: AGRIBUSINESS HUMAN RELATIONS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Describe common difficulties in getting along with others on the job.
2. List some ideas for getting along with the boss.
3. Analyze some employee relations problems.

MOTIVATION:

Give the students a case situation to discuss.
EXAMPLE: You are employed at an implement dealership and notice one of the other workers put some nuts, washers and bolts in his lunch box. What should you do?

Teacher suggestions:
- a. Report to the boss
- b. Not say anything
- c. Replace them yourself
- d. Talk to the worker about it

REFERENCES:

Handout: "Worker Situation"

OUTLINE:

A. Common Types of Human Relations Situations

    1. Employer-Employee Relations
    2. Supervisor-Employee Relations
    3. Employee-Employee Relations
    4. Customer-Employee Relations

B. Employer-Employee Problems

    1. Recognize the problem.

2. Gather facts about the problem.
3. Find the best solution to the problem.
4. Carry out your solution.

C. Undesirable Worker Traits to Review and Aid in Avoiding Difficulties

1. Griping to everyone
2. Being jealous
3. Gossip
4. Showing little consideration for others' rights
5. Being an "apple-polisher"
6. Acting as a supervisor
7. Taking credit for achievements and ideas of others
8. Running down other people
9. Using (exploiting) other people
10. Playing one side against another for personal gain

D. Employers Expectations

1. Respect for authority
2. Personal authority
3. Personal characteristics
4. Adherence to business rules and policies
5. Regular attendance

E. To Get Along With the Boss

1. Make good use of constructive criticism
2. Be loyal to supervisors
3. Recognize the boss as an individual
4. Contribute new ideas

TEACHING LEARNING ACTIVITIES:

1. Discuss with the class the different forms of human relations situations that exist in an occupation.

2. Discuss with the class the problem that might occur in a job and how difficulties can be avoided. Refer to the outline information as an aid to the discussion.

3. Hand out a written description of an employee situation. Have the students give a written solution to the problem and report their conclusion. Discuss the situations and conclusions with the class.

SUGGESTED EVALUATION:

1. Written quiz of material discussed during the lesson.

2. Evaluation of the group reports and class participation.

WORKER SITUATION

Mr. Jones owns and manages a large swine operation. He has several feedlots on different farms and a farrowing business on other land. He spends a good deal of his time marketing the hogs which leaves little time to be at each of his facilities.

Since he is unable to directly oversee the work he has appointed a foreman. The foreman in turn makes the work assignments to the four employees.

One of the men took another job so Mr. Jones was in need of a new worker. He interviewed and hired Dan Smith, a recent high school graduate. Dan had been highly recommended by his vocational agribusiness teacher. Mr. Jones felt that by maybe hiring an energetic young worker that the amount and quality of work the farm crew was doing would improve.

In less than a week Dan recognized the problem of less than the suitable amount of work being performed. He was emptying the pits and spreading manure at one of the lots. By 3:30 p.m., he had made 4 trips to the field and felt he had time to load up one more load and spread it when the foreman came over to the tractor and complimented him on his work.

When Dan told the foreman that he was planning to haul another load out the foreman said that what he had done was enough for the day. He told Dan that nobody works too hard or accomplishes so much that he causes somebody else to get fired.

What should Dan do?

TEACHERS USE

Choices

1. Dan could have hauled out the manure anyway and ignored the foreman. This would get him more recognition from the boss.
2. He could have followed the foreman's advice.
3. He could have told the boss so the boss would know what was going on.
4. He could have talked to the workers to see if they wanted to get more done.
5. He could have taken the foreman's advice and not do the real noticable jobs but since he wanted to work, do the little jobs of cleanup or basic chores that the other workers didn't like anyway and would help keep the operation more orderly.

UNIT IV

SUPERVISED OCCUPATIONAL EDUCATION
Introduction to the Unit

The S.O.E. unit for Agribusiness II is structured to allow the students to maintain good record keeping practices and to continue their individual enterprise programs. This unit will allow students to examine their progress on gaining experience in a line of agribusiness. It will also allow each student to evaluate the individual projects and determine how the skills being learned can be applied to their chosen career area.

LESSONS:

1. Updating Records
2. Summarizing and Annalyzing Records
3. Determining Long-Range Plans
4. Planning the Enterprise for Year II

OBJECTIVES:

Upon completion of this unit the student will be able to:

1. Keep accurate and up-to-date records.
2. Annalyze the efficiency factors of the enterprise.
3. Make long-range program plans.
4. Plan for the next year's projects.

MOTIVATION:

Plan a field trip to a farming operation or an agribusiness to discuss with the manager his record keeping methods. View the operation and discuss how each phase of the business records are kept. Have a question sheet for students to aid them in gaining pertinent information on record keeping.

TEACHING REFERENCES:

A. General References

1. Indiana Vocational Agriculture Record, The Interstate Printers
2. Indiana Vocational Agribusiness Record, The Interstate Printers
3. Indiana Vocational Agriculture Farming Program Record, The Interstate Printers
4. Chapter FFA Guide, Indiana FFA Association
5. Chapter FFA Handbook, Indiana FFA Association

B. Addresses for Reference Materials

1. The Interstate Printers and Publishers, Inc.
Danville, ILL 61832

2. Indiana FFA Association
120 W. Market St , 16th Floor
Indianapolis, IN 46204

OTHER REFERENCES

1. Plant Science Core Curriculum
Instructional Materials Laboratory
10 Industrial Education Building
University of Missouri
Columbia, Missouri 65201

2. Vocational Agriculture Education,
Basic Core Curriculum
State Department of Vocational and Technical Education
Stillwater, Oklahoma

LESSON 1: UPDATING RECORDS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List reasons for using enterprise record-keeping.
2. List kinds of records that are to be kept.
3. Record items correctly in the record books.
4. Calculate prices and costs in records.

MOTIVATION:

Invite a well organized farmer or agribusinessman to speak to the class on what types of records should be kept and review with the class his or her record keeping system.

REFERENCES:

Indiana Vocational Agriculture Record, The Interstate Printers

Indiana Vocational Agribusiness Record, The Interstate Printers

Indiana Vocational Agriculture Farming Program Record, The Interstate Printers

OUTLINE:

A. Reasons for Using an Individual Enterprise Record System
    1. Aids in planning future operations.
    2. Allows comparison of one enterprise to another.
    3. Identifies management decisions for each enterprise.
    4. Determines efficiency of management for each enterprise.

B. Kinds of Records to be Kept
    1. List and description of jobs to be performed.

2. Expenses.
3. Labor.
4. Machinery use.
5. Inventory.
6. Receipts.
7. Diary of special situations that affected the enterprise.

TEACHING LEARNING ACTIVITIES:

1. Discuss with students the reasons for keeping records on an individual enterprise basis.
2. Review the record keeping information in the record books.
3. Give a simple quiz on what records are to be kept and how they are to be figured.
4. Allow students to get their records up to date and close out the year's records. Check each student's work for neatness and accuracy.
5. Review the section on closing inventories and net worth statements in the record books.
6. Allow students to complete the net worth statements and closing inventories.

SUGGESTED EVALUATION:

1. Test students on record keeping information.
2. Provide students with sample records to close out. (See S.O.E., Agribusiness I)
3. Assign grades to students' enterprise records.

LESSON 2: SUMMARIZING AND ANNALYZING RECORDS

OBJECTIVE:

At the completion of the lesson the student will be able to:

1. Compute the profit or loss for the enterprise.
2. Analyze the efficiency of the enterprise.
3. Determine a cost breakdown for each unit of the enterprise.
4. Describe the general situation for the year that affected yields, prices, costs, or labor by consulting the record diary.

MOTIVATION:

Ask students if they are satisfied with the results of their previous year's records. Ask different students why they are satisfied or dissatisfied. Ask the students if they could improve their operations from the previous year. Lead into discussion of the importance of analyzing records. Point out that an important reason for record keeping is to allow a person to plan for the future. (Refer to Agribusiness I on reasons for keeping records.)

REFERENCES:

Indiana Vocational Agriculture Record, The Interstate Printers

Indiana Vocational Agribusiness Record, The Interstate Printers

Indiana Vocational Agriculture Farming Program Record, The Interstate Printers

Year's Records on an Indiana Farm, I.C.M.C.

OUTLINE:

A. Calculation of Unit Costs

  1. Breeding enterprise

    a. Number of breeding animals.
    b. Percent of calf crop, percent of lamb crop, or number of pigs weaned per litter.
    c. Weight of calves or pigs at weaning.

2. Feeding enterprise

   a. Number of animals on feed.
   b. Starting weight of animals.
   c. Final weight of animals.
   d. Number of days on feed.
   e. Total gain in pounds.
   f. Pounds gained per day.
   g. Pounds of feed fed.
   h. Pounds of feed required per pound of gain.

3. Crop enterprise

   a. Number of acres.
   b. Amount of seed used per acre.
   c. Kind, pounds per acre, and cost per acre of fertilizer used.
   d. Yield per acre.
   e. Cost per bushel or ton.

4. Dairy project

   a. Number of cows
   b. Average production per cow.
   c. Average butterfat production per cow.
   d. Returns per cow of milk sold.
   e. Total returns per cow.
   f. Feed cost per 100 pounds of milk produced.

5. Laying flock project

   a. Number of layers.
   b. Percent death loss during year.
   c. Eggs produced per hen per year.
   d. Feed cost per hen per year.
   e. Returns per hen per year.
   f. Returns above feed cost per hen.
   g. Feed cost per dozen eggs produced.
   h. Total project cost.
   i. Total cost per dozen eggs produced.
   j. Pounds of feed per dozen eggs produced.

6. Poultry meat project

   a. Percent death loss.
   b. Average value per bird marketed.
   c. Feed cost per bird marketed.
   d. Returns above feed cost (per bird).
   e. Feed cost per pound weight marketed.
   f. Total project cost.
   g. Total cost per pound weight marketed.
   h. Returns per $1.00 feed fed.
   i. Pounds of feed required per pound weight produced.

B. Efficiency of Project

1. Efficiency factors (examples)

   a. Amount of labor.
   b. Amount and cost of feed.
   c. Amount and cost of seed and fertilizer.
   d. Amount of time for machinery use.
   e. Death loss.
   f. Weaning weights.
   g. Market price, and grade and yield.
   h. Daily gains.
   i. Yields
   j. What work should be accomplished in a certain amount of time.

2. Comparing with desirable levels

   a. Consult with text books.
   b. Market prices.
   c. Test examples.
   d. Feed efficiency.
   e. Weaning weights and average daily gains.
   f. Yields.
   g. Amount of work on the job and what was accomplished.

3. Comparison of students efficiencies of the same project

4. Analysis of the project by making comparisons citing differences

TEACHING LEARNING ACTIVITIES:

1. Use a completed record book and point out how the summary page is to be filled out.

2. Allow students to complete the summaries of their enterprises. If not all students have projects of this nature make copies of other students information and alter some of the figures allowing each student the opportunity to fill these out. Another alternative is to allow students that don't have crop, livestock, or other production projects to keep records of the FFA land laboratory.

3. Take some of the summaries and make transparencies of them to be used for class discussion of how to analyze the enterprise.

4. Divide the class into groups and have them select the efficiency factors and a goal for each factor for an enterprise.

5. After the efficiency factors have been determined have students write an analysis of their productive projects. Suggest that answers for why crops, livestock, or other projects showed high

or low might be discovered by consulting the record book diary.

SUGGESTED EVALUATION:

1. Evaluate the students program summaries and their written analyses of the projects.

LESSON 3: DETERMINING LONG-RANGE PLANS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Evaluate the previous year's program by listing the strong and weak points.
2. Make long range program plans relating to the program evaluation.
3. Determine how the program will help them in their future employment.

MOTIVATION:

Since the class has now been through a full year with their projects they can now see more clearly what their chances are for expansion or for changing their operations whether it be in an occupation or with a production enterprise. Give the students an example of how an older FFA member has set and achieved long range plans. Discuss with class the different proficiency areas and the State and American Farmer Agribusinessman Degrees and how these awards and degrees take advanced planning.

REFERENCES:

Indiana Vocational Agriculture Record, The Interstate Printers

OUTLINE:

A. Strong Points to Consider

    1. Breeding

        a. 90% calf crop
        b. 150% lamb crop
        c. 8.5 pigs weaned per litter
        d. Weighing equipment
        e. Facilities

    2. Feeding

        a. Efficiency
        b. Weighing equipment

  - c. Parasite and disease control
  - d. Facilities
  - e. Water supply

3. Dairy

   - a. Records
   - b. Production testing
   - c. Sanitation
   - d. Parasite and disease control

4. Strong egg production

   - a. Egg quality
   - b. 60-70 eggs per 100 hens per day
   - c. Parasite and disease control
   - d. Water supply
   - e. Sanitation
   - f. Culling
   - g. Death loss

5. Crops

   - a. Quality
   - b. Fertilizer
   - c. Weed control
   - d. Yield
   - e. Seedbed preparation

TEACHING LEARNING ACTIVITIES:

1. Once the students have summarized and annalyzed their projects they are now ready to evaluate their project. Show the students they can evaluate their projects by looking over their summaries and written analysis from the previous lesson.

2. Allow each student time to figure the strong and weak points of the project and record these points on paper.

3. Suggest that by looking at their project evaluation they can determine some long range plans for the next several years.

4. Divide the class into groups and have them aid each other in deciding how they can plan their projects on a long range scale.

5. Next, have each student decide individually if the group decisions on long range plans should be changed or altered.

6. Have the students report their long range plans to the rest of the class.

7. The teacher should use a set of plans from a student from another class as an example of how the program can help a student in future employment.

8. Have each student write a statement describing how the various experiences can aid them in future employment.

9. Suggest that the students use their careers unit information to see if the projects will aid them in achieving employment in their career interest area.

10. Have students report on how their long range plans can help them prepare for getting involved in their chosen careers.

SUGGESTED EVALUATION:

1. Evaluate the group and individual activities.

2. Assign grades to the written plans.

LESSON 4: PLAN THE ENTERPRISE FOR YEAR II

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Complete a proficiency award application.
2. List the requirements for the State Farmer Agribusinessman Degree.
3. Plan increases or changes in the enterprise based on analysis of previous year's records and to reflect the schedule on long-range plans.
4. Plan improvement projects and supplementary projects which can be achieved.
5. Plan FFA activities (for the next year) that will aid in the operation of the enterprise.

MOTIVATION:

Now that the student has determined a long range plan he needs to look at plans for the coming year to help him strive for those future goals. Each year a good manager should base his management decisions on his past records and his future plans. How can this statement be justified?

REFERENCES:

"FFA Proficiency Award Applications", Indiana FFA Association

State Farmer/Agribusinessman Degree Application, Indiana FFA Association

Indiana Vocational Agriculture Record, The Interstate Printers

Indiana Vocational Agribusiness Record, The Interstate Printers

Indiana Vocational Agriculture Farming Program Record, The Interstate Printers

OUTLINE:

A. Proficiency Awards Information

1. Available to all FFA members enrolled in high school vocational agribusiness programs and to members who have been out of high school not more than one year and have completed at least three years of vocational agribusiness or all the vocational agribusiness offered in the school.

2. Complete summaries of the enterprise for each year.

3. Record other sources of income.

4. Fill out the inventory section.

5. Complete a financial statement.

6. List the most significant skills or competencies.

7. List the most significant improvement projects.

8. Describe the experiences gained from the activities.

9. List the efficiencies obtained in the enterprise.

10. List activities relating to the enterprise.

11. List achievements in the FFA.

12. List other school and community activities.

13. Supply background information of family, business, special practices that were used, future plans.

14. Include a statement from employer or instructor.

15. Include from 6 to 10 pictures with a brief caption (50 words or less) for each.

B. State Farmer/Agribusinessman Degree Application Qualifications

1. Received Chapter Farmer Degree and been an active FFA member for two years (24 months).

2. In high school - must be enrolled in at least the second year of instruction.

3. Out of high school - completed equivalent of two full years of systematic secondary school instruction in addition to an S.O.E. project.

4. Have earned and invested $500 by his own efforts from an S.O.E. program or have worked at least 600 hours in laboratory experience program.

5. Demonstrate leadership ability (see National Constitution).

6. Meet other requirements established by the State Association.

C. FFA Activities to Aid the Operation of the Enterprise

1. Judging contests

2. Demonstrations

TEACHING LEARNING ACTIVITIES:

1. Review the proficiency award areas with the students allowing each student to select at least one area that would coincide with their project.

2. Make ditto copies of the applications and hand them to the students. Review the information on how to fill them out by using a transparency copy of several example forms.

3. Allow students time to complete the applications. After they are completed check them and return them to the students for future reference as they complete each year's records. Another suggestion would be to review the application forms with the class then keep them in a student file.

4. Discuss the requirements for the State Farmer/Agribusinessman Degree and point out that each student should plan to submit an application during their junior or senior year.

5. Make copies of the State Farmer/Agribusinessman Degree applications and discuss how they should be filled out.

6. Allow students to take their long range plan formulations and plan the enterprise for the coming year.

7. Hand out new record books and have students fill out the pertinent sections. Assist students in determining estimated receipts and expenses for their projects.

8. Have students plan improvement projects and supplementary farm jobs.

9. Discuss with the class the FFA activities that should be planned to aid them in their projects. Encourage 100% participation in activities.

SUGGESTED EVALUATION:

1. Assign grades to written work on applications and records.

UNIT V

MECHANICS

Introduction to the Unit

The Agricultural Mechanics materials provided in Agribusiness II will give the student further knowledge and skills in several areas. The areas to be reviewed include arc welding, oxy-ocetylene gas welding, metal work, pipe fitting, electricity, and farm shop planning.

LESSONS:

1. Arc Welder Equipment Usage and Safety
2. Striking the Arc and Running a Bead
3. Position Welding
4. Using the Carbon Arc Torch
5. Carbon Arc and Metal Electrode Arc Cutting
6. Cast Iron Welding
7. Pipe Welding
8. Safety and Operation of Oxy-Acetylene Welding Equipment
9. Welding with the Oxyacetylene Torch
10. Cutting with the Oxyacetylene Torch
11. Brazing with the Oxyacetylene Torch
12. Hard-Surfacing with the Oxyacetylene Torch
13. Metal Identification
14. Cutting and Filing Metal
15. Drilling Metal
16. Shaping Cold Metal
17. Threading
18. Plumbing Tool and Pipe Selection
19. Preparing Pipe for Assembly
20. Assembling Pipe

21. Fundamentals of Electricity
22. Electrical Safety
23. Electrical Wiring
24. Planning a Service Center
25. Selecting and Storing Tools

OBJECTIVES:

Upon the completion of this unit the student will be able to:

1. Practice standard safety procedures.
2. Demonstrate use of the electric arc welder.
3. Demonstrate use of the oxyacetylene gas welder.
4. Identify, select, and work with different metals.
5. List the types of pipe for the intended use.
6. Demonstrate methods of pipe assembly from different types of pipes.
7. List electrical safety precautions.
8. Demonstrate wiring simple electrical circuits.
9. Plan the wiring needs of a building.
10. Plan a service center.
11. Select and store tools in a service center.

TEACHING REFERENCES:

A. General References:

"Lincoln Electrodes Selection Chart", The Lincoln Electric Company

The Lincoln Short Course, The Lincoln Electric Company

Modern Welding, Goodhart-Wilcox Company

Shopwork on the Farm, McGraw-Hill Book Company

Maintaining the Lighting and Wiring System, AAVIM

Agricultural Wiring Handbook, Edison Electric Institute

Electrical Wiring, Sears

B. Addresses for Reference Materials:

1. The Lincoln Electric Company
   Cleveland, Ohio 44117

2. Goodhart-Wilcox Book Company, Inc.
   South Holland, Illinois 60473

3. McGraw-Hill Book Company
   Manchester Road
   Manchester, Missouri 63011

4. AAVIM
   Engineering Center
   Athens, Georgia 30602

5. Edison Electric Institute
   90 Park Avenue
   New York, New York 10016

6. Sears, Roebuck and Co.
   Any Sears Store

7. Smith Welding Supplies
   2633 S.E. 4th Street
   Minneapolis, Minnesota 55414

C. Other References:

1. Plant Science Core Curriculum
   Instructional Materials Laboratory
   10 Industrial Education Building
   University of Missouri
   Columbia, Missouri 65201

2. Agricultural Mechanics I, II, III, IV.
   Vocational Instructional Services
   Texas A & M University
   F E Box 182
   College Station, Texas 77843

3. Vocational Agriculture Education, Basic Core Curriculum
   State Department of Vocational and Technical Education
   Stillwater, Oklahoma

D. Handout:

1. "Electrical Conditions Survey"

LESSON 1: ARC WELDING EQUIPMENT USEAGE AND SAFETY

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List safety precautions used in arc welding.
2. Describe the difference between types of welders.
3. List the different welding equipment that is used.
4. Write the meaning for the numbers in the electrode classification system when provided an electrode.
5. Describe the importance of the electrode coating.
6. List four types of electrodes.
7. List the two most common sizes of electrodes.

MOTIVATION:

Set up the welder with correct amperage and electrode. Use a brick and set up so electrode will weld when holder in place on the brick after arc is started. Before beginning this demonstration tell class that anyone can weld.

REFERENCES:

"Lincoln Electrodes Selection Guide" (Wall chart)

The Lincoln Short Course, The Lincoln Electric Company

Modern Welding, Goodhart-Wilcox Co.

Transparency Masters: "AC Arc Welding Machine"
"Classification of Electrodes"
"Welding"

OUTLINE:

A. Basic Information

1. Arc welding dates back to the latter part of the nineteenth century when experimenters discovered that the arc between two carbon electrodes could be used to melt most metals. The arc, struck between the carbon electrode and the metal, heats the metal to a melting point, then the electrode is removed to break the arc and let the metal freeze.

2. Arc - Flow of current across a narrow gap.

3. Base metal - Metal to be welded.

4. Bead weld - Made by one pass of the electrode.

5. Bevel - Type of edge preparation.

6. Butt joint - Weld between two metal parts on the same plane.

7. Crater - Depression at the end of weld.

8. Electrode - Metal rod which conducts a current from the electrode holder to the base metal.

9. Arc welding may be defined as the process of fusing two or more pieces of metal together by using the heat produced from an electric welding machine.

10. AWS - American Welding Society

B. Advantages of Arc Welding Are:

1. Scrap metal can be used to make many useful items.

2. Repairs can be made rapidly on farm machinery and equipment, which is good insurance during harvest time and other critical periods.

3. Minor cracks or breaks can be repaired before they cause a major repair problem.

4. Metal repair and construction jobs may be accomplished more economically with an arc welder than with other types of metal repair and construction equipment.

5. The arc welder can be used for jobs that require cutting, piercing, gouging, and beveling metal.

C. Safety Practices to Observe When Using the Arc Welder

1. Most injuries that are caused by arc welding machines can be prevented if certain precautions are observed. The five major safety items that are of utmost importance are:

a. Electrical Shock - The open circuit voltage of an AC welder may not exceed 90 volts, but the electrode holder and welder should always be handled with care. Some of the safety practices include:
   (1) Be sure the welder is properly grounded.
   (2) Secure services of a competent electrician when making an electrical installation.
   (3) Do not run machinery over welding cables.
   (4) Do not stand on wet surfaces when welding.
   (5) Use only electrode holders that are well insulated.
   (6) Wear leather gloves.

b. Radiant Energy - The arc welding process gives off the same ultra-violet rays as those transmitted by sunlight. The rays given off by the welder are more concentrated than the sun rays. The safety practices to observe are:
   (1) Cover the face and eyes with a shield or helmet before striking an arc.
   (2) Give a warning to all people standing by before striking an arc.
   (3) Examine the helmet for cracks that would let in light.
   (4) Wear protective clothing such as high top shoes, long sleeves, buttoned collars, cuffless pants, and welding gloves. Burns can be caused by wearing improper clothes.

c. Gases and Fumes - Gases and fumes are usually not a safety problem when welding in a well ventilated shop. A fan may be needed to reduce fumes when welding galvanized metal.

d. Combustible Materials - Welding enclosed containers which have held combustible materials is very dangerous. There is a definite danger of an explosion unless all precautions are observed.

2. Miscellaneous safety rules

   a. Do not lay an electrode holder on the welding table.
   b. Do not stand on metal that is grounded.
   c. Keep work area clean to avoid falling or slipping.
   d. Keep tools and equipment in a safe place so they will not fall on the operator.
   e. Do not hold the electrode holder between the knees or under the arm.
   f. If the electrode sticks and cannot be twisted free, cut off switch to the machine; allow electrode to cool and break it loose with pliers.
   g. Do not cool electrode holder in water.
   h. Never rub the eyes if foreign particles get in them.

D. Types of Arc Welding Machines

1. An AC (alternating current) welder is the most common type for general agriculture use. It ranges in size from 180 to 225 ampheres and performs best where the power supply is between 220 and 240 volts.

   a. Advantages of using 180 to 225 amp AC welding machine are:
      (1) They are large enough to handle most welding jobs.
      (2) The initial and maintenance costs are lower than a welding machine above 225 ampheres.
      (3) A 180 amphere AC welder has a "limited input" of no more than 37.5 ampheres on a 230 volt single-phase circuit.
      (4) The 225 amphere welder, being somewhat larger, can handle electrodes one size larger than the 180 amphere welder, and on some jobs the welding can be accomplished somewhat faster.

2. DC (direct current) welders are generator-type welding machines that are powered by electric motors, gasoline engines, or other power sources.

   a. Advantages of using DC welders are:
      (1) Portable models, powered by engines, can be mounted on trucks or trailers and taken to the work.
      (2) Electric power is not necessary for a gasoline powered welder; therefore, they can be used as mobile units for repair work in industry.
   b. DC welders produce direct current of both straight (negative) and reverse (positive) polarity. Polarity is the direction in which the current flows across the arc.
      (1) Straight polarity is when the electrode is negative and the work is positive.
      (2) When the electrode is positive and the work is negative, the adjustment is reverse polarity.
      (3) Cast iron, thin metal, aluminum, and bronze is welded with a reverse polarity adjustment. Mild steel is welded with a straight polarity adjustment.

3. AC/DC welders are essentially welders equipped with a rectifier (an electronic device to convert AC to DC). If the rectifier is not operating, the welder is an AC type.

   a. Advantages of AC/DC welding machines are:
      (1) With the rectifier operating, direct current is produced.
      (2) The noise usually encountered when operating a DC welder is eliminated with a rectifier.
      (3) T.I.G. (Tungster Inert Gas) uses nonconsumable tungsten electrode and an inert shielding gas.

(4) M.I.G. (Metal Inert Gas) uses a base wire filler material that is fed automatically into weld; also has an inert shielding gas.

E. Common Arc Welding Equipment

1. Welder
2. Electrode holder with lead
3. Ground clamp with lead
4. Shield or helmet
5. Gloves
6. Chipping hammer
7. Safety goggles
8. Wire brush
9. Electrodes

F. Types of Electrodes

1. Mild steel
2. High carbon steel
3. Hard surfacing
4. Alloys-Special purpose
5. Cast iron

G. Common Sizes of Electrodes Used in Agricultural Mechanics

1. 1/8"
2. 5/32"

(NOTE: Sizes of electrodes range from 1/16" to 3/8". Electrode size is determined by the diameter of the wire.)

H. Electrode Classification and Selection

All major manufactures of welding electrodes use the code of specifications prepared for testing materials by the American Welding Society (AWS). There are several manufacturers of electrodes; and each company makes basically the same quality, if they follow the AWS specifications.

1. Electrodes may be identified in the following manner:

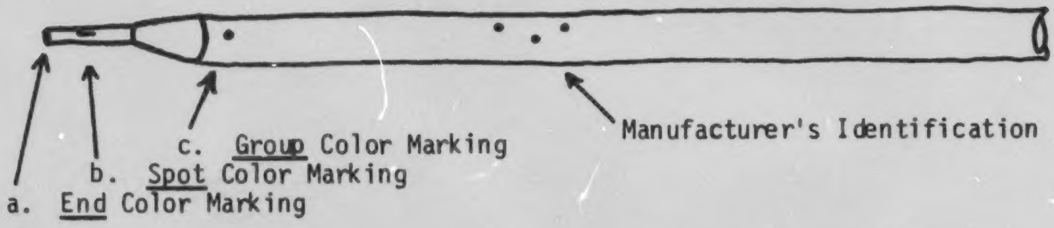


Table I

Fig. No. 1

ASTM AWS Class	Mfg. Co.	Trade Name or Number	Color Markings	
			End	Spot
E6013	Hobart	447A	None	Brown
E6013	Lincoln	Fleetweld 37	None	Brown
E6013	Airco	6013	None	Brown
E6011	Hobart	335A	None	Blue
E6011	Lincoln	180.	None	Blue
E6011	Marquette	130.	None	Blue

The Meaning of the AWS class number (E6013) is:

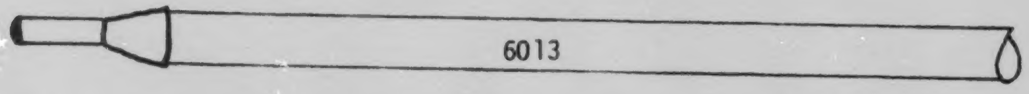
E - The electrode for electric arc welding.

60 - The tensile strength of the electrode metal (psi). Example: 60 X 1,000 or 60,000 pounds per square inch.

1 - Weld flat, horizontal, vertical, and overhead. If the third number is a 2, it can be used for flat and horizontal welding, but a 3 means flat only.

3 - May mean the chemical analysis of the flux; the polarity of the electrode, AC or DC rating or the penetrating capacity of the electrode. The E6011 will penetrate deeper and have less slag than an E6014 electrode.

2. The size of the electrode to use depends on the job to be performed. The actual size of an electrode is determined by the bare end of the rod.



Specifications for an E6013 Electrode

Standard Size Diameter of core wire	Approximate No. of Electrode per pound	Standard Length	Amperage Rating
1/16 inch	53	18"	20 - 40
3/32 inch	36	12"	30 - 80
1/8 inch	17	14"	70 - 120
5/32 inch	11	14"	120 - 170
3/16 inch	8	14"	140 - 240

3. One of the main purposes of the flux on an electrode is to furnish a gaseous smoke screen to envelop the arc and protect the molten metal from harmful atmospheric effects of nitrogen and oxygen. The flux coating that does not burn to form the gaseous shield mixes with the metal impurities and settles as slag on the welded metal.

I. Methods of Coating Electrodes

1. Wrapping

2. Dipping

(NOTE: Electrodes are dipped into a liquid flux solution.)

3. Extruding

(NOTE: This is the most common method.)

J. Purposes of Electrode Coating

1. Stabilizes the arc

2. Shields molten puddle from air

3. Floats impurities out of puddle

4. Forms slag and slows cooling

5. Increases speed and improves quality of weld

TEACHING LEARNING ACTIVITIES:

1. Give a pretest on outline information to determine the knowledge of the students of welding. Review the basic information on the quiz with the class.

2. Discuss with the class what safety precautions are needed when welding.

3. Have students list some advantages to knowing how to weld.

4. Review with students the controls and parts of the arc welders that are in the shop. Emphasize the safety and the clean-up procedures. Show the transparency "AC, Arc Welding Machine."

5. Discuss with students basic shop rules and show them where welding projects and materials are to be stored.

6. Have students provide the names of welding equipment that will be used and list the names on the chalk board.

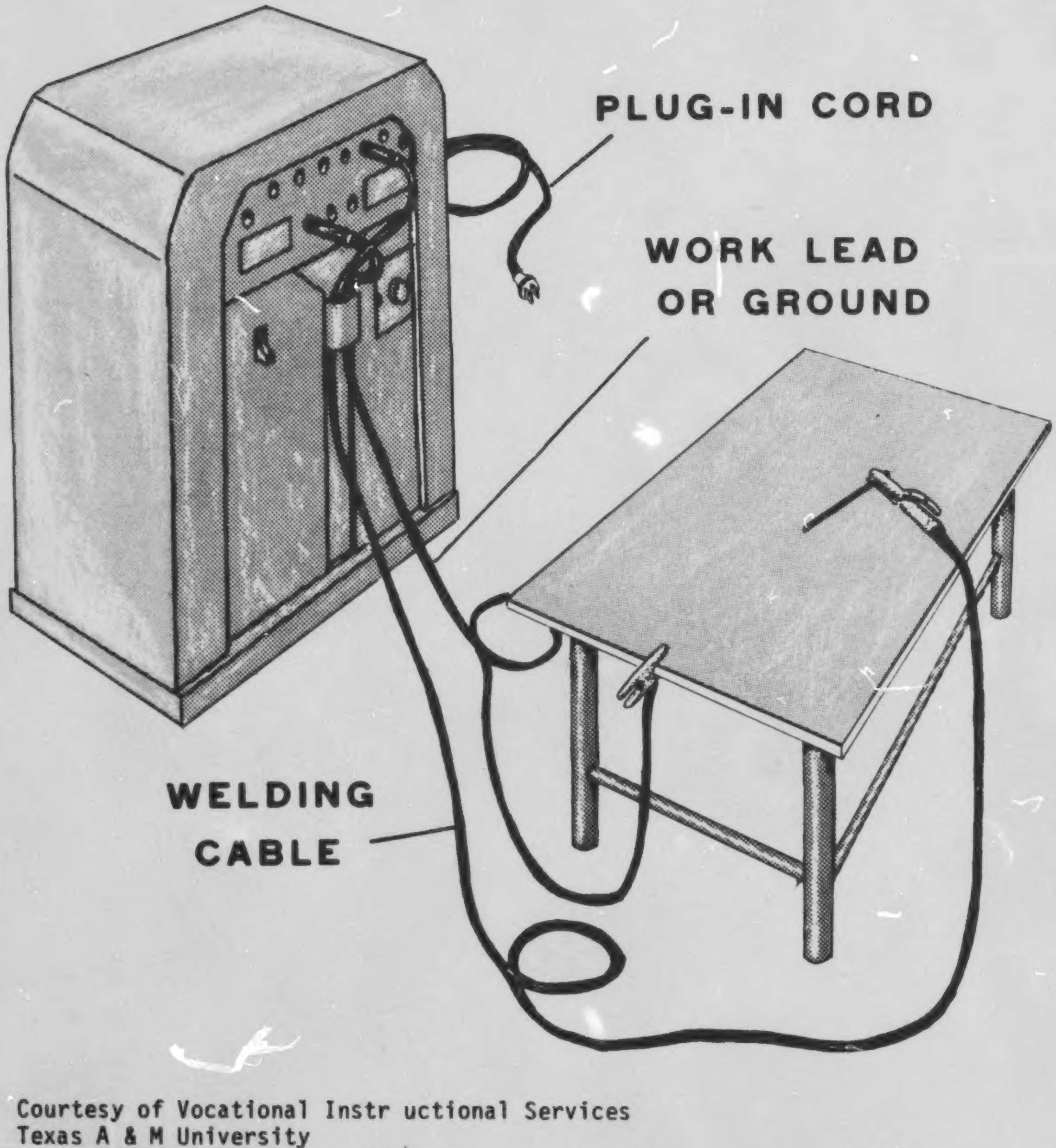
7. Show the transparency "Classification of Electrodes" and review with the class the meaning of the numbers. Show some different types of electrodes and explain the differences. Use a chart or other materials to aid in showing the students various types of electrodes.

8. Show the students the transparency "Welding Process." Explain each part of the diagram and ask students questions about the transparency.

SUGGESTED EVALUATION:

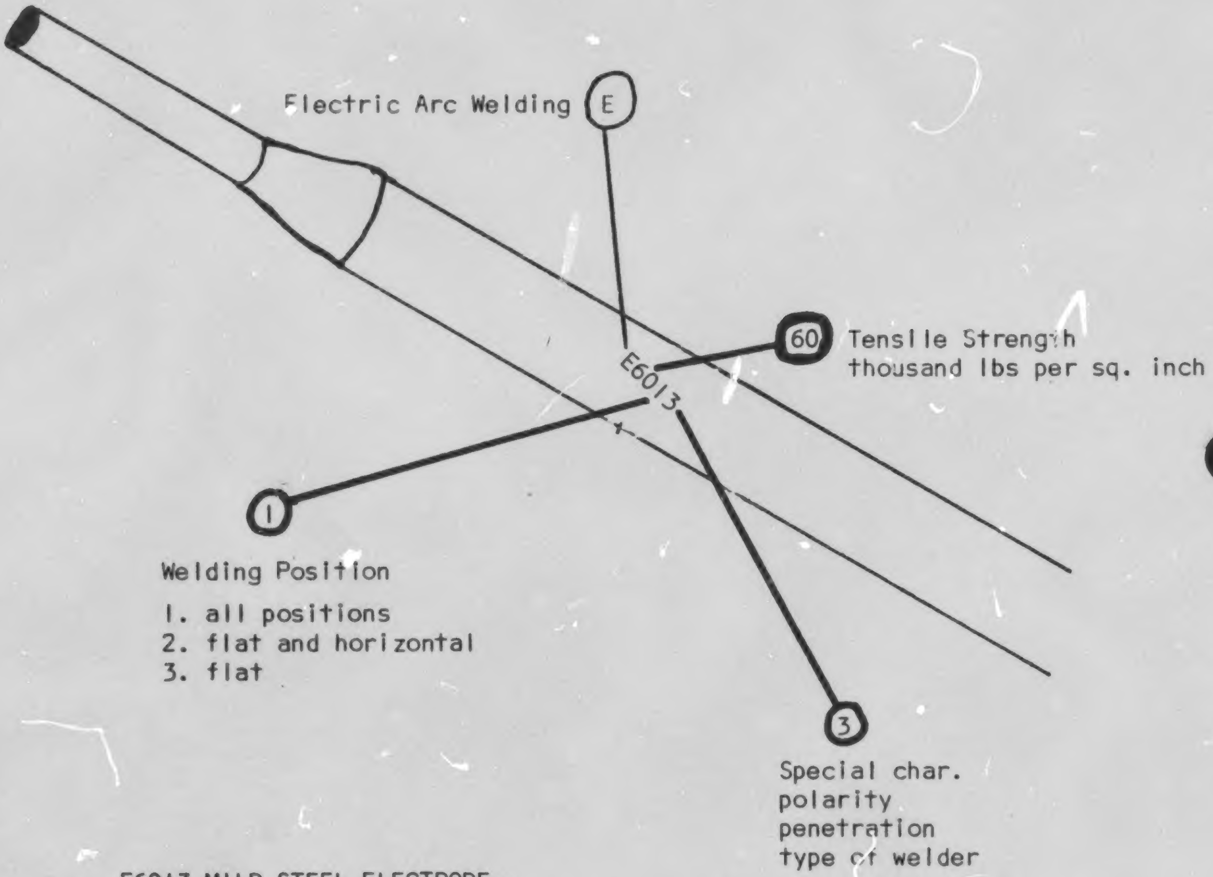
1. Written quiz to cover material discussed in lesson.

AC ARC WELDING MACHINE


PLUG-IN CORD
WORK LEAD OR GROUND
WELDING CABLE

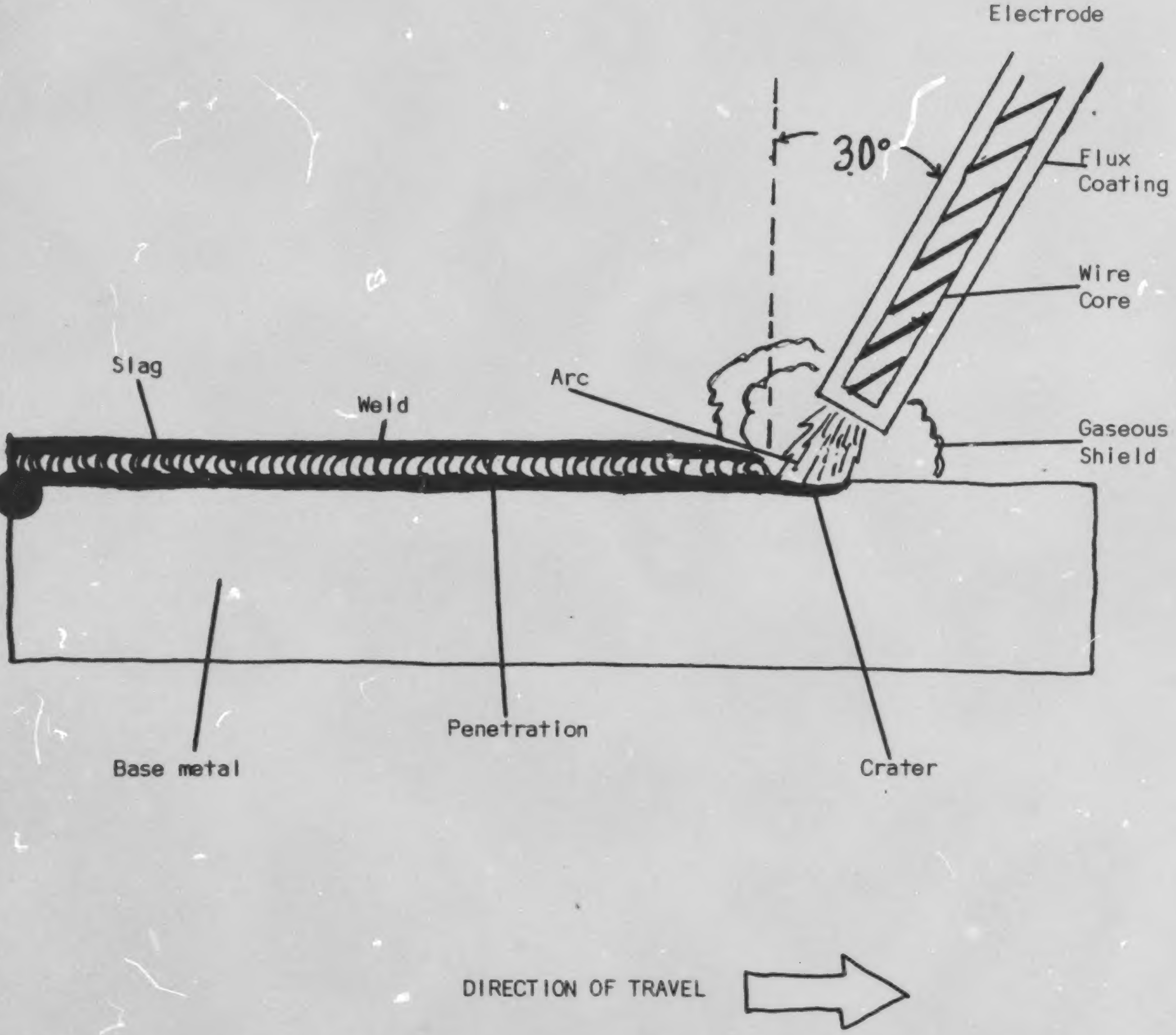
Courtesy of Vocational Instr uctional Services
Texas A & M University
College Station, Texas 77843

CLASSIFICATION OF ELECTRODES
AWS


Electric Arc Welding
E
E6013
60
Tensile Strength
thousand lbs per sq. inch
1
Welding Position
1. all positions
2. flat and horizontal
3. flat
3
Special char.
polarity
penetration
type of welder

E6013 MILD STEEL ELECTRODE

Welding


Electrode
30°
Flux
Coating
Wire
Core
Slag
Weld
Arc
Gaseous
Shield
Base metal
Penetration
Crater
DIRECTION OF TRAVEL

LESSON 2: STRIKING THE ARC AND RUNNING A BEAD

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Prepare the metal for welding.
2. Strike and maintain an arc.
3. Run a steady and straight bead on a practice welding pad.

MOTIVATION:

Allow each student to attempt striking and holding the arc at different amperage settings.

REFERENCES:

The Lincoln Short Course, The Lincoln Electric Company

Modern Welding, Goodhart - Wilcox Co.

Transparency Masters: "Proper Preparation of Stock"
"Adjusting the Current"
"Welding Procedure"
"Starting the Arc and Laying the Bead"
"Steps in Running a Bead"
"Padding and Weaving"

Equipment Information: 3/16" mild steel plate
1/8" AWS, E6011 Electrode
Amperage setting at 90-100 amps

OUTLINE:

A. Basic Information:

1. Pad--series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer.
2. Root--bottom surface of a weld; the opposite side from which the welding was done.

3. Penetration--distance from the original surface of the base metal to that point at which fusion ceases.

4. Undercutting--portion of the crater left unfilled due to excessive current and the improper movement of the electrode; occurs at the edge of the bead

5. Fusion--melting of metals until the molten parts unite with each other.

6. Spatter--deposit of small spots or particles of metal on the base metal alongside the bead (Transparency 3).

7. String bead-weld bead made with very little rod manipulation.

8. Root opening--gap between the members to be joined at the root of the joint.

9. Porosity--condition caused by a trapped gas pocket in a weld as it solidifies.

10. Slag inclusion--nonmetallic porous material entrapped in weld metal or between the weld metal and base metal.

11. Cold lap--piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld.

12. Arc blow--concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path.

13. Coupon--that portion of a weld which is removed from the test plate to test.

B. Preparation of Metal

1. The metal should be cleaned by brushing, filing, grinding, and scraping.

2. If the pieces of metal are less than 1/4" thick, the surface may be ground to remove the casting skin.

3. Metal that is more than 1/4" thick should be beveled to a 30° angle.

4. If stock is beveled the unground surface should be 1/16" to 3/32" thick.

5. Pieces that are more than 1/4" thick should be spaced 1/32" to 1/16" apart before welding.

C. Current Should be Adjusted Properly

1. Determined by:

   a. length of cables
   b. thickness of metal
   c. diameter and type of electrode
   d. speed of travel

2. Amperage too high - bead is flat and porous and edge will be spattered.

3. Amperage too low - high narrow bead, not have proper penetration.

D. Welding Operation

1. Correct welding positions (a left-handed person should reverse the procedure).

   a. Sit or stand in a relaxed position to avoid fatigue.
   b. Hold the electrode holder in the right hand. Place the left hand on the underside of the right hand.
   c. If in a sitting position, put the left elbow on the left knee.
   d. Hold the electrode holder firmly and weld with both hands, if possible.
   e. The movement of the electrode should be from left to right.
   f. The position of the electrode should be in line with the weld and leaning at about a 15 degree angle to the metal or in the direction of travel.

E. Starting the Arc

1. An arc if formed in a circuit when the electrode is brought in contact with the metal surface and then withdrawn slightly. The current jumps this gap and makes an arc hot enough to melt the metal surface and the electrode.

2. Two methods of striking an arc are as follows:

   a. Tapping method:
      (1) Set the welding machine to the correct current.
      (2) Bring the tip of the electrode straight down and tap it on the metal surface.
      (3) After striking the arc, hold the electrode tip between 1/8 and 1/4 inch above the stock to allow the arc to become established before starting the weld. Begin welding with the tip 1/8 inch above the bottom of the crater.
      (4) Tilt the electrode about 15 degrees in the direction of travel to make the weld.

b. Scratching method:
   (1) Set the welding machine to the correct current.
   (2) Bring the tip of the electrode down in a sweeping motion (the motion for striking a match).
   (3) Raise the electrode 1/8 inch at the end of the sweeping motion.
   (4) As the molten crater forms, maintain the 1/8 inch distance between the tip and the bottom of the crater.
   (5) Tilt the electrode 15 degrees for making the weld.

2. The correct arc length may also be determined by sound. When the arc is too long, it will give off a bellowing sound. If the arc length and amperage are correct, the arc will give off a continuous crackling or frying sound.

3. The correct arc length will eliminate excessive spattering, overlapping, and undercutting. It will give fairly deep penetration with the proper fusion of metals.

4. If the electrode sticks to the plate or stock, it should be broken loose with a quick twisting or bending motion. If it becomes welded to the plate, disengage the holder and break it loose with pliers.

5. Causes of Difficulties in Starting an Arc

   a. Flux coating is chipped on the electrode tip. A fast scratching method and finishing the sweep with a long arc is the best way to strike an arc.
   b. The work is improperly ground. Arcing may occur where ground clamp is attached to the metal. Metal should be clean where clamp is attached.
   c. Improper electrode contact in the holder jaws. The holder may have a weak spring, foreign material in the jaws, or the jaws may be holding the electrode by the flux coating.
   d. Failure to use the correct electrode for the recommended amperes or metal stock.

F. Steps in Laying a Bead

1. Before laying a bead, the welding machine should be adjusted to the proper amperage. For example, a 1/4 inch plate can be welded with an 1/8 inch or larger electrode at an amperage setting between 80 and 110; but if a 3/8 inch plate is welded, more heat is needed to bring the metal up to a molten state. A 5/32 inch electrode and an amperage setting of 160 is recommended to weld a 3/8 inch plate.

2. The second most important step is to hold a long arc until the base metal begins to melt, and continue to watch the puddle instead of watching the arc.

3. After the metal begins melting, the electrode should be brought down to form the proper arc length and the top slanted toward the line of weld for running a bead.

4. Maintaining a good puddle is one of the most important steps in making a good weld. The puddle should be about 1 1/2 times as wide as the width of the electrode. The slag should not flow in front of the puddle.

5. In order to maintain a good puddle, the speed of travel must be adjusted to permit a desired bead height. Usually, welding a heavy plate requires a slower speed than welding a thin plate.

6. If the arc is broken while running a bead, it should not be started in the same place (the crater of the interrupted bead). It should be started on the metal ahead of the crater. The weld passes back through the crater toward the bead and then back over the same path in the line of weld.

7. The best way to fill a crater at the end of a bead is to push the end of the electrode down into the crater, almost to the sticking point and pull it away quickly to break the arc.

8. The electrode movements for laying a weld bead are:

   a. The downward feeding of the electrode to maintain the desired arc length.
   b. The movement along the weld line.

G. Welding on a Pad

1. Begin welding a bead in the upper left-hand corner of the plate; maintain the bead longitudinally flush with the upper edge of the plate while moving from left to right.

2. Both ends of the weld must be flush with the edge of the plate; therefore, the crater should be filled at the end of the bead.

3. Chip and wirebrush the bead until it is perfectly clean before laying another bead along its side.

4. Place the second bead so that it will fuse with one-fifth of the first bead.

5. Repeat each padding step until the entire surface of the plate or area is completely covered with deposited metal and is flush on all four sides.

6. The welding operator should learn the different positions for welding under different welding conditions. The arc cannot be moved from left to right at all times. The other three positions include:
   a. Without changing the position of the practice plate, begin at the lower left-hand corner and lay the bead away from the body. Use steps 2, 3, and 4 for padding. Cover the entire plate and brush clean for the next layer.
   b. Deposit a third layer without moving the plate, but move the arc from right to left. Again, use steps 2, 3, and 4 for padding. Brush all beads clean before starting the fourth layer.
   c. Add the fourth layer with the steel plate in the initial position. Clean the plate so that the beads can be examined.

TEACHING LEARNING ACTIVITIES:

1. Ask the students what steps have to be followed to begin a weld. Make a list of the steps and discuss each item. For example, prepare the metal and adjust amperage. Discuss what should be done to prepare the metal, and show the transparencies "Proper preparation of stock" and "Adjusting the currents."

2. Hand out a list for the students to study reflecting the general information. Tell them they will be quized over the material later.

3. Discuss and demonstrate the correct welding positions. To aid discussion show the transparency "Welding Procedure."

4. Discuss the methods of starting the arc and show "Starting the Arc and Laying the Bead." Demonstrate how to start the arc.

5. Allow each student to practice starting and maintaining an arc.

6. Discuss the transparency "Steps in Running a Bead." Demonstrate the procedure of running a bead.

7. Allow each student to practice running a bead.

8. Show the transparency, "Padding and Weaving" to illustrate to students the next shop assignment.

9. Have pads available for students and allow students time to completely fill one pad while checking their work. Grade the completed pads.

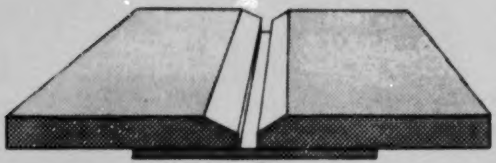
10. Have students make several layers and check their work.

SUGGESTED EVALUATION:

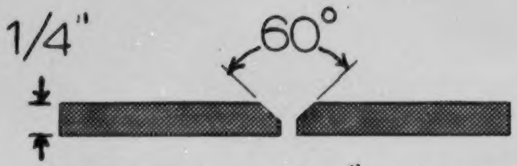
1. Quiz students on the information sheets and the class discussions.
2. Grade the students' shop work.

V-23T

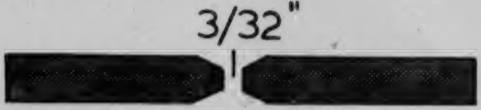
PROPER PREPARATION OF STOCK



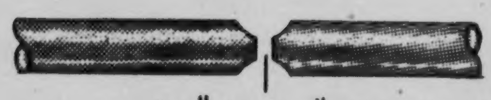
ONE SIDE BEVELED



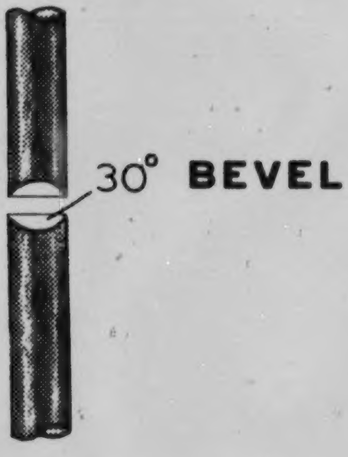
SPACED 3/32" APART



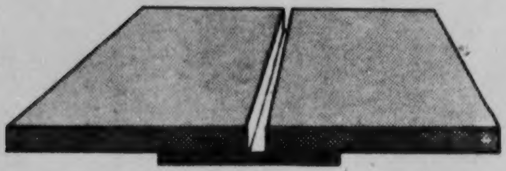
TWO SIDES BEVELED



1/16"–1/32" OPENING



ROUND STOCK
BEVELED ON TWO SIDES



JOINT WITHOUT BEVEL

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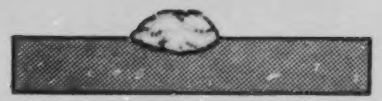
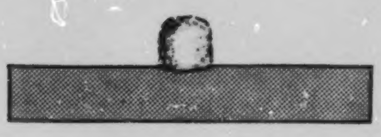
V-24T

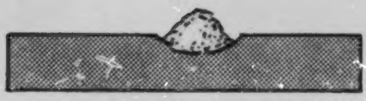
ADJUSTING THE CURRENT



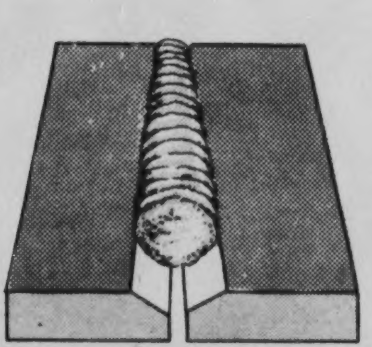
NORMAL BEAD



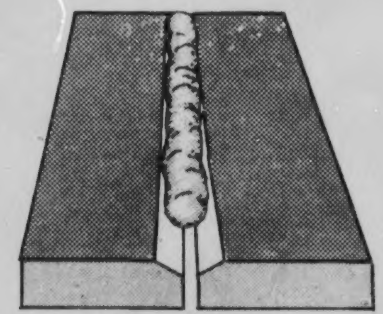
HIGH BEAD
(low penetration)



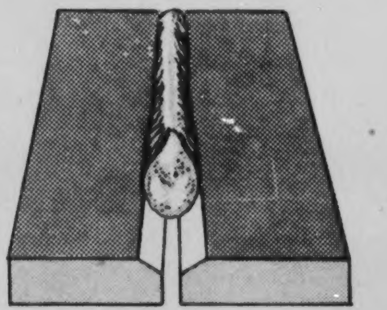
LOW BEAD
(under cutting)



CORRECT AMPERAGE



LOW AMPERAGE



HIGH AMPERAGE

AMPERAGE	ELECTRODE SIZE	METAL THICKNESS
65	3/32"	1/16"
80-100	3/32"	3/32"
80-110	1/8"	1/8"
115-130	5/32"	3/16"
130-150	5/32"	1/4"
140-150	5/32"	5/16"
160-175	5/32"	3/8"
175-200	5/32"	1/2"

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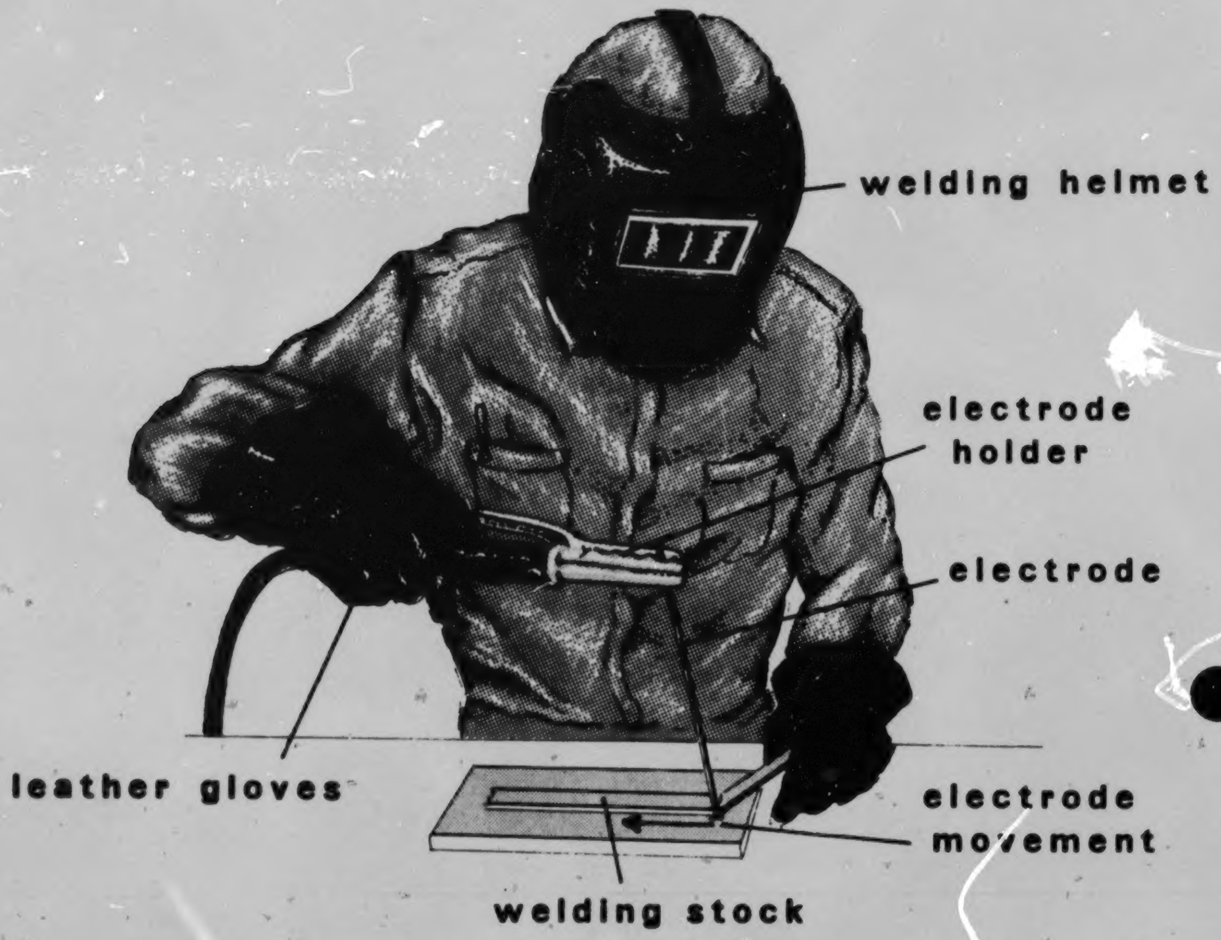
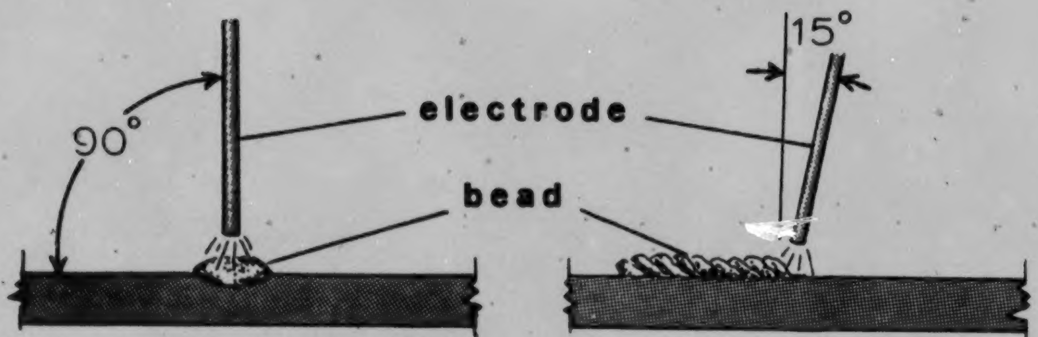
V-25T

WELDING PROCEDURE


welding helmet
electrode holder
electrode
leather gloves
electrode movement
welding stock


90°
15°
electrode
bead

electrode held at 90° to each side of plate

electrode at 15° angle in direction of travel

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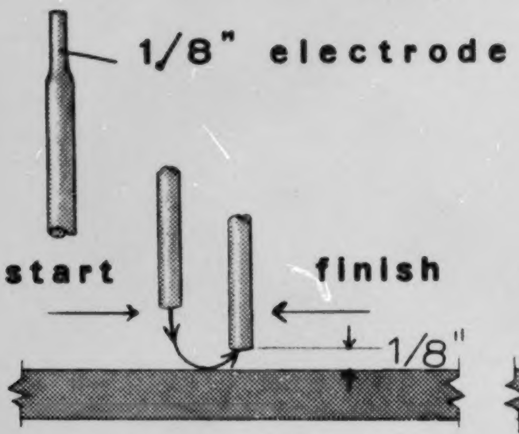
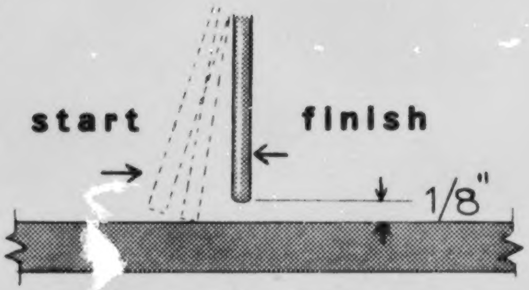
V-26T

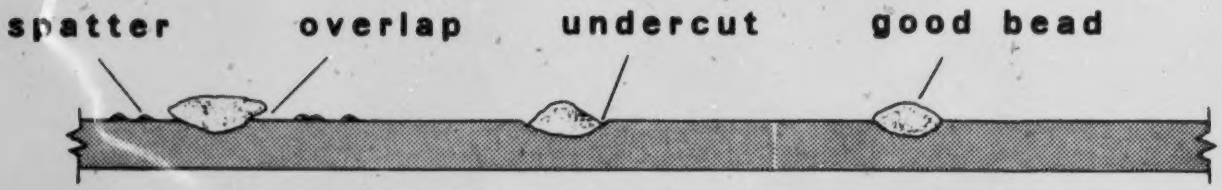
STARTING THE ARC AND LAYING THE BEAD


1/8" electrode
start
finish
1/8"

TAPPING METHOD


start
finish
1/8"

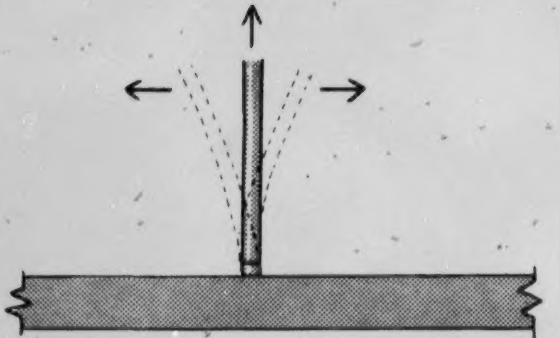
SCRATCHING METHOD


spatter
overlap
undercut
good bead

POOR PENETRATION

DEEP PENETRATION

PROPER PENETRATION



STUCK ELECTRODE IS BENT FROM SIDE TO SIDE AND PULLED UP

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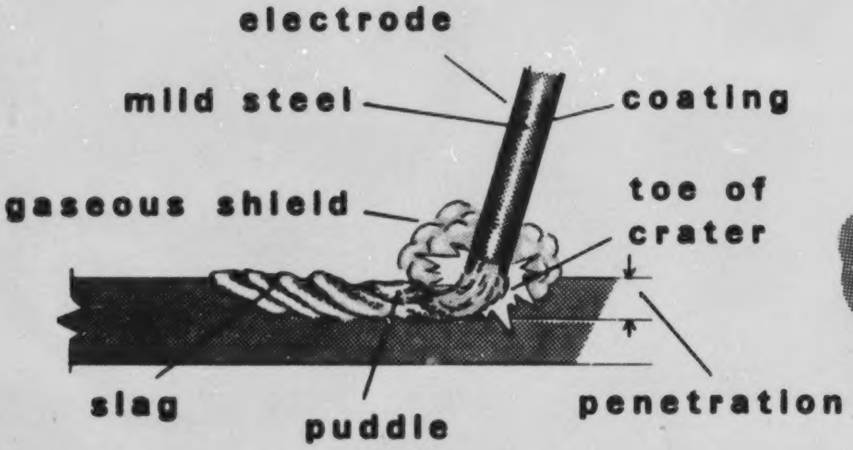
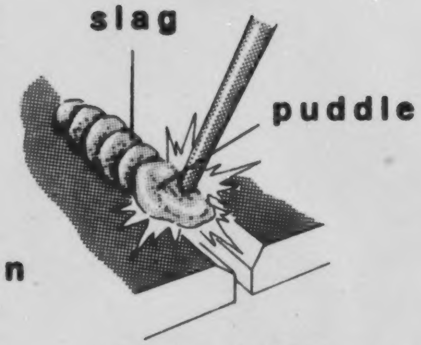
STEPS IN RUNNING A BEAD

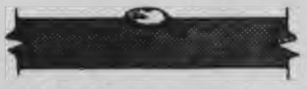

electrode
mild steel
coating
gaseous shield
toe of crater
slag
puddle
penetration

Starting a Bead and Maintaining a Good Puddle

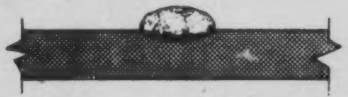

slag
puddle

Slag Following Behind Puddle

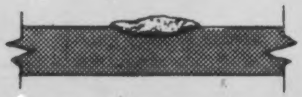
THREE TYPES OF BEADS



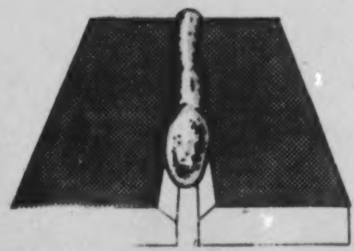
Narrow and Thin Bead



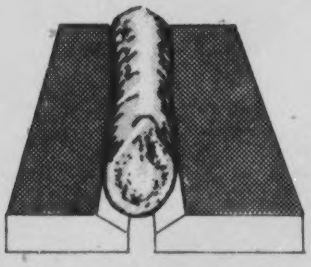
Wide and Piled-up Bead



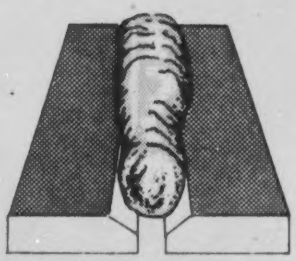
Flat and Irregular Bead



Moving Fast



Moving Slow



Using Long Arc

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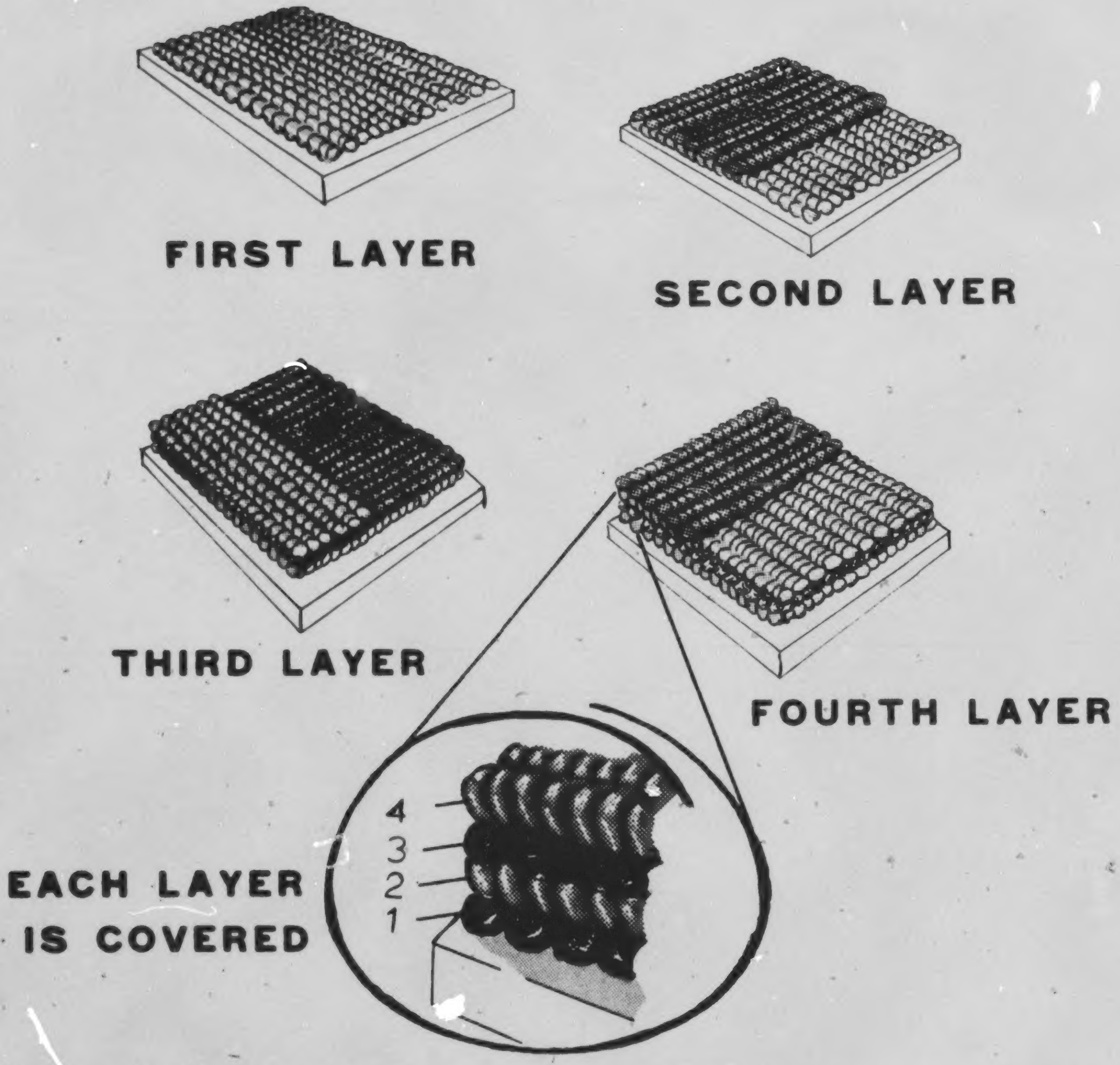
PADDING AND WEAVING


FIRST LAYER
SECOND LAYER
THIRD LAYER
FOURTH LAYER
4
3
2
1
EACH LAYER IS COVERED

COMPLETE PAD HAS FOUR LAYERS

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LESSON 3: POSITION WELDING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Identify kinds of welds, types of weld joints, and different welding positions from diagrams and examples.

2. Perform different prescribed welds in different welding positions.

MOTIVATION:

The fact that the students are going to be working with the welder in practicing welding should apply motivation. Encouragement to students by the teacher as the students are welding will help in motivation.

REFERENCES:

Transparency Masters: "Steps in Making Butt Welds"
"Steps Used When Making Fillet welds"
"Other Welding Positions 1, 2, 3,"

OUTLINE:

A. Kinds of Welds (Transparency 3)
   1. Fillet
   2. Groove
   3. Bead

B. Types of Weld Joints
   1. Edge Joint
   2. Butt Joint
   3. Corner Joint
   4. T Joint
   5. Lap Joint

C. Weld Positions

1. Flat
2. Vertical
3. Overhead
4. Horizontal

D. Reasons for Poor Welds

1. Machine adjustment too hot or too cold
2. Electrode size too large or too small
3. Improper movement of electrode
4. Improper angle of holding electrode
5. Arc length too long or too short

E. Butt Weld

1. Preparation of base metal by beveling edges if base metal over 1/8" in thickness.
2. Place the two pieces of metal parallel to each other leaving a space of 1/16" to 3/32" between them.
3. Tack weld pieces together at both ends.
4. Make one single pass to weld the two pieces together.
5. Chip slag and brush the weld.

F. Flat Position V-Groove Butt Weld

1. Use E6011 or E6013 electrode.
2. Set current at 75-130 amps for 1/8" electrode or 90-175 amps for 5/32" electrode.
3. Bevel one long side of each plate. Leave about 1/8" unbeveled along bottom of each.
4. Place plates parallel to each other leaving a gap of 1/8" to 3/32" (use a "v" shaped spacer wire to maintain the gap)
5. Tack the pieces together
6. Strike a high arc into joint and move to end.

7. Weld plates together with one pass (the bead should completely penetrate leaving an overlap of 1/16" on top and bottom of joint.

8. Chip away slag and brush weld.

9. Fill out the bevel or "v" with filler passes.

   a) remove all slag between passes.
   b) make passes slightly convex overlapping edge at groove 1/16" on each side.
   c) cool plates slowly.

G. Making a pad in the horizontal position

1. Position metal for horizontal welding and tack.

2. Position electrode down 5° - 10° and angled 20° in direction of travel.

3. Strike high arc and hold 1-2 seconds in lower beginning corner then make one pass.

4. Chip and brush each weld clean.

5. Each pass should overlap previous bead at least 1/3 until pad is filled.

6. Can use alternate travel for each pass (left to right, then right to left, etc.)

H. V-Groove Butt Weld in verticle up position.

1. Follow same preparations as Outline F.

2. Position plates in verticle position.

3. Place electrode straight into joint and angle it 5-10° up from horizontal.

4. Strike and hold a high arc to heat plates then move to bottom and start weld.

5. Melt out each part (keyhole) as large as the electrode diameter.

6. Fill the crater to about 3/16" of bead width.

7. If arc is broken remove slag from end of bead and restrike arc below the keyhole. (melted through hole).

8. Remove slag and brush after each pass.

9. Make filler passes to complete weld.

I. V-Groove Butt Weld in overhead position

   1. Prepare plates

   2. Tack plates

   3. Position plates in overhead position.

   4. Hold electrode straight into plate vertically and angled 5°-10° in direction of travel.

   5. Strike arc move to end of plates and start weld.

   6. Hold short arc length and keep end of electrode half into root gap.

   7. Deposit thin layers of metal using rod manipulation to control puddle.

   8. Deposit filler passes to joint use stringers and weavers. Clean slag from weld after each pass.

J. Continuous Bead.

   1. Using a short pipe and plate weld a continuous bead sealing pipe and plate.

   2. Hold electrode 25° from pipe.

TEACHING LEARNING ACTIVITIES:

1. Tell students that now that they have learned specific welding procedures they are ready for practicing different common welds. Discuss the kinds of welds and show the related transparency.

2. Discuss the types of weld joints and the welding positions. Show the corresponding transparencies to aid the discussion.

3. Assign working stations and hand out the instructions of "E" in Outline. Demonstrate how to construct a butt weld.

4. Hand out each outline section after the previous job is completed and demonstrate the procedure for completing the job. Allow students to complete each job.

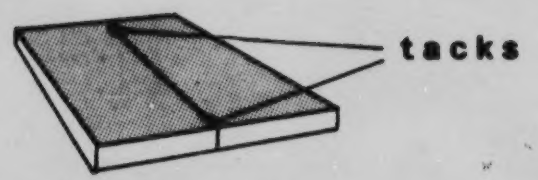
5. Another method to teach this section is first to demonstrate how to do each and leave a display for students to view. Allow students to contract their grades.

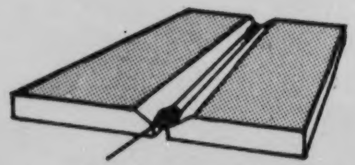
- a. 6 jobs completed accurately receives an A grade
- b. 5 jobs completed receives a B grade
- c. 4 jobs completed receives a C grade
- d. 2-3 jobs completed receives a D grade

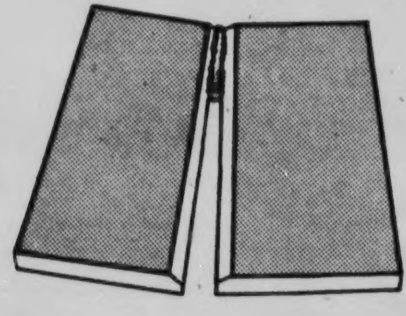
SUGGESTED EVALUATION:

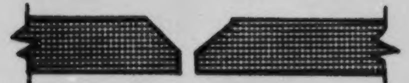
1. Grade each job as it is completed or use contract system.

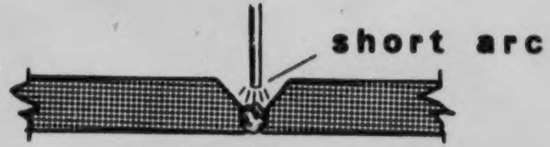
STEPS IN MAKING BUTT WELDS



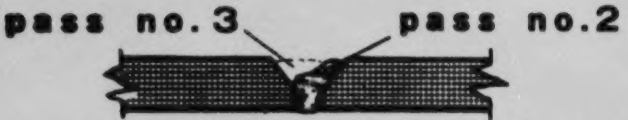

tacks on beveled metal


no tacks used - metal moves apart

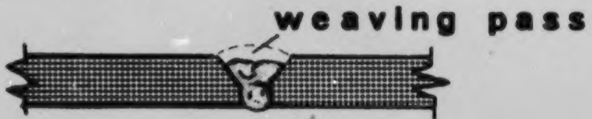

butt weld plates



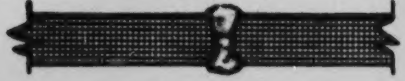
pass no. 1

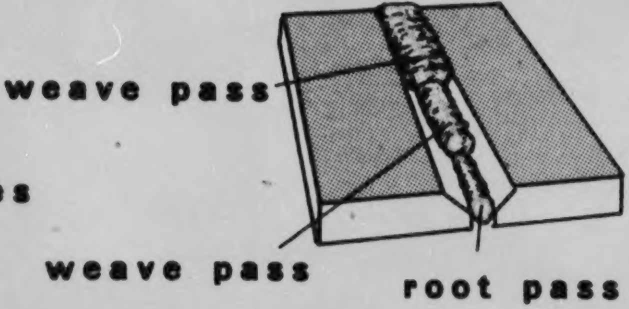

pass no.3
pass no.2

passes no. 2 and 3


weaving pass

pass no.4


pass from both sides of plate


weave pass
weave pass
root pass

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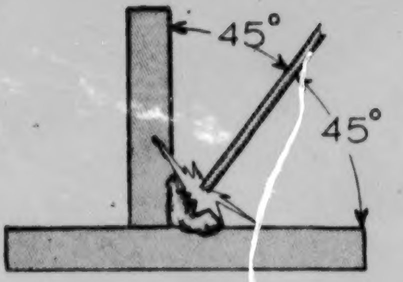
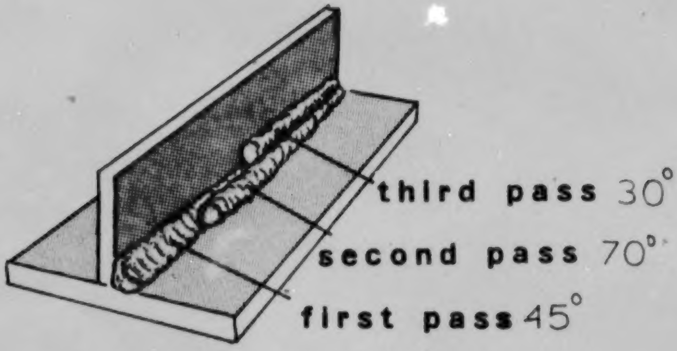
V-35T

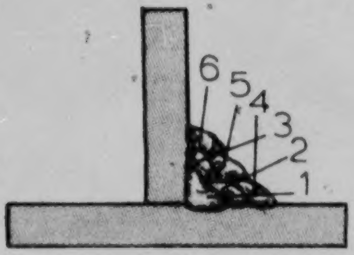
STEPS USED WHEN MAKING FILLET WELDS



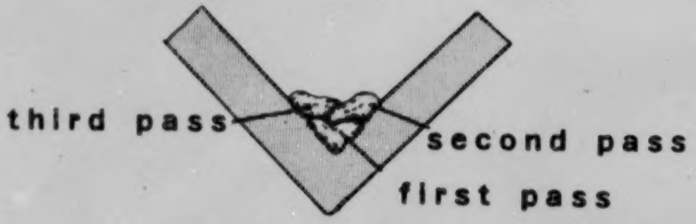
metal welded forming T


third pass 30°
second pass 70°
first pass 45°

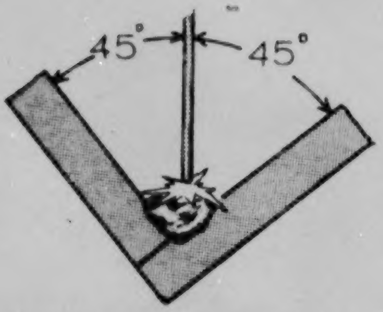
position of electrode



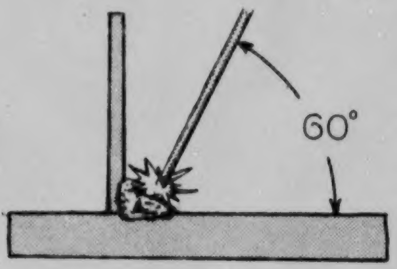
six pass weld


third pass
second pass
first pass

V-weld position



electrode held at 45 on first pass



thin metal welded to thick metal

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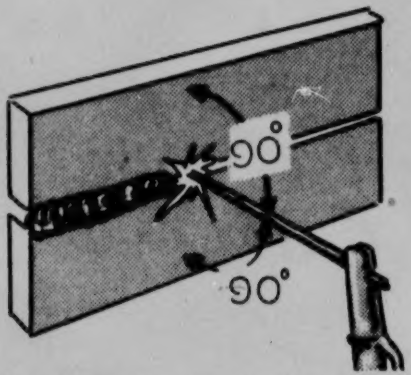
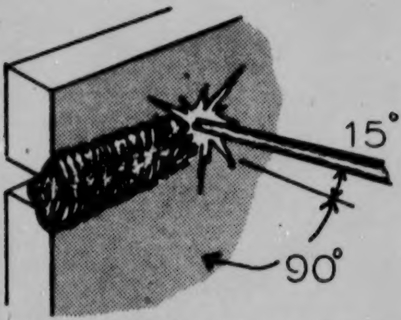
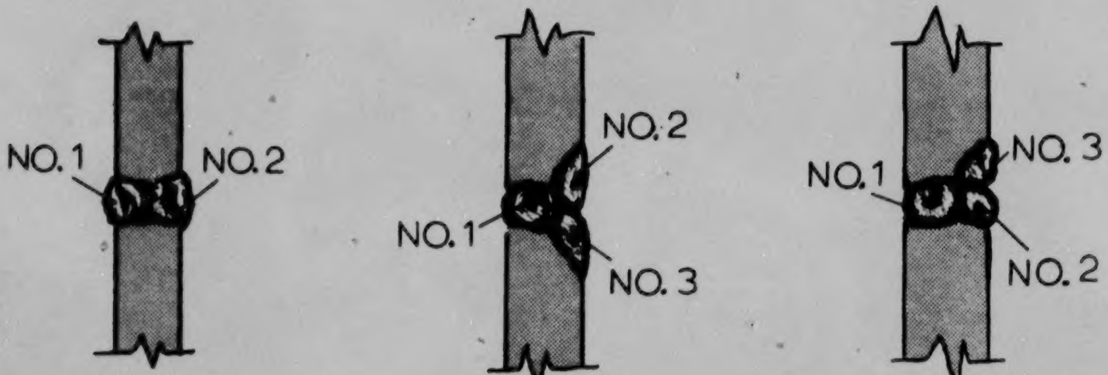
OTHER WELDING POSITIONS



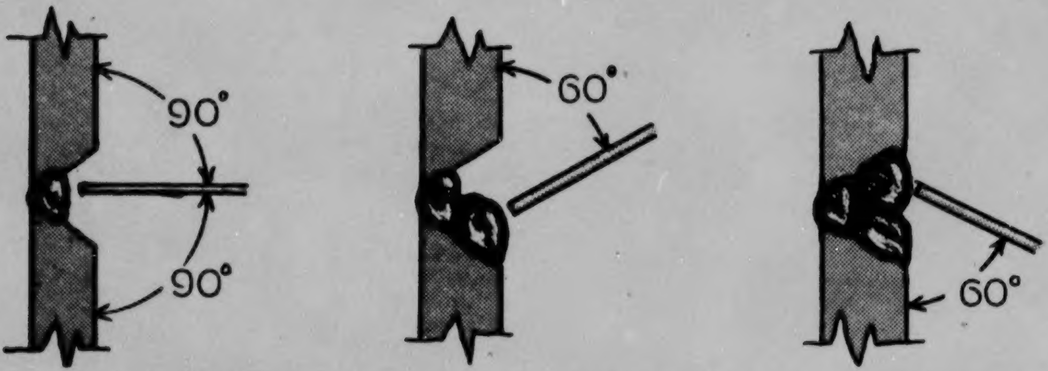
PROPER ELECTRODE POSITION - HORIZONTAL WELDING



SLIGHT WEAVE FOR STRAIGHT EDGES


NO.1
NO.2
NO.2
NO.1
NO.3
NO.3
NO.1
NO.2

PASSES FOR WELDING HORIZONTAL BUTT JOINTS



ELECTRODE POSITION - MULTIPLE WELDS

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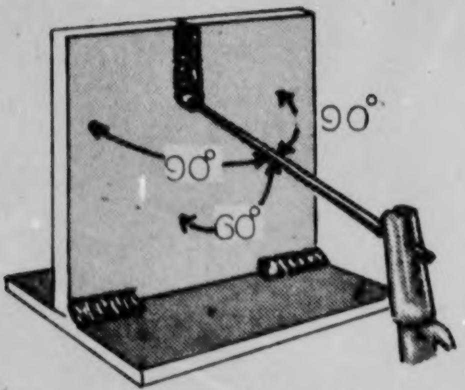
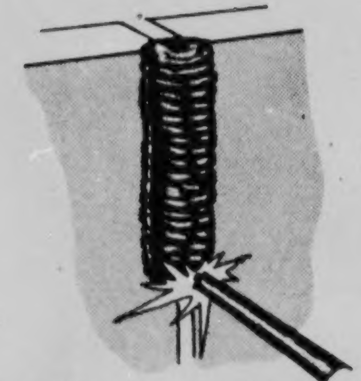
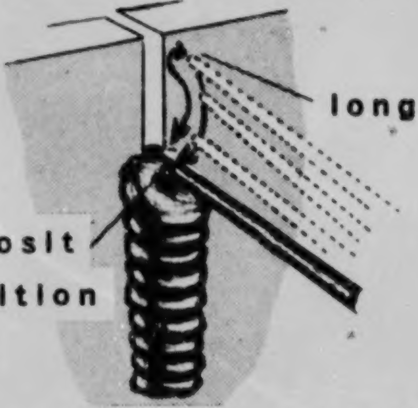
OTHER WELDING POSITIONS



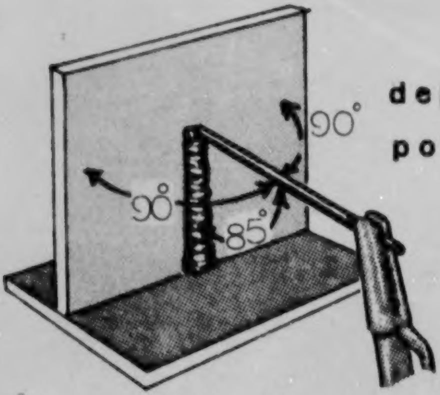
vertical down



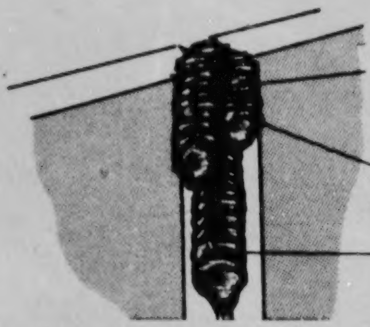
vertical down weave


long arc
deposit position

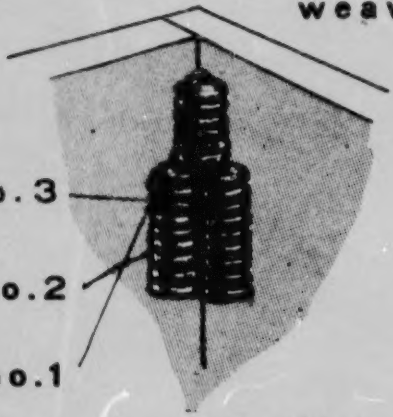
motion for whipping weave



vertical up


pass no.3
pass no.2
pass no.1

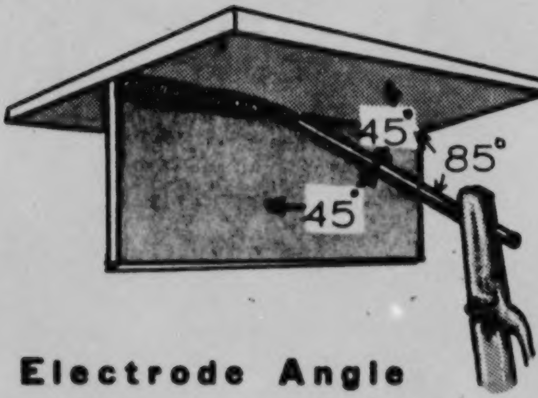
ertical down multiple pass



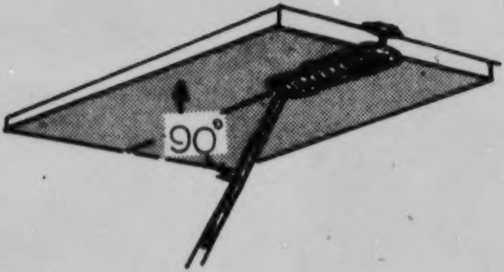
vertical up multiple pass

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

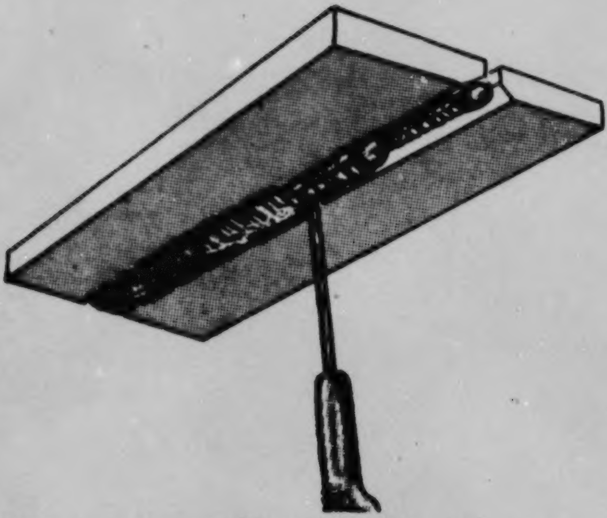
OTHER WELDING POSITIONS



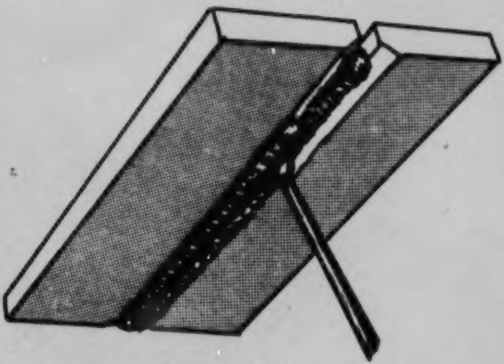
**Electrode Angle
Overhead Fillet Weld**



**Overhead Butt Weld
Bead on Two Sides**



**Weaving Butt Weld on
Second and Third Passes**



**Straight Beads Fused
Together - Overhead
Welding**

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

LESSON 4: USING THE CARBON ARC TORCH

OBJECTIVE:

At the completion of the lesson the student will be able to:

1. Install a set of carbons in a holder and adjust properly.
2. Heat and bend metal.
3. Braze with the carbon arc torch.
4. Solder with the carbon arc torch.
5. Cut with the carbon arc.

MOTIVATION:

Demonstrate the different uses of the carbon arc torch.

REFERENCES:

Modern Welding, Goodhart - Willcox Co.

OUTLINE:

A. Principles of Carbon Arc:

   1. Produces arc between metal and carbon electrode or between two carbon electrodes.
   2. The arc produced will melt the base metal and metal may be added by using a filler rod.
   3. When two carbon electrodes are used the arc is struck between them and can melt the base metal by the radiating heat.
   4. Carbon electrode prepared for use by grinding to a cone tapered 6 to 8 times the diameter of the electrode.
   5. Electrode should stick out of the holder 10 times the electrode diameter.

B. Heating and Bending Metal:

1. Heat to a bright red.
2. Hammer to the desired shape.

C. Brazing:

1. 1/8" bronze rod and bronze welding flux.
2. Use a 3/16" plate.
3. Heat base metal dull red and apply flux and bronze filler rod.
4. Hold flame close to work, about 1/8"
5. If base metal too cool the filler rod metal roles into balls, if too hot, filler rod metal runs to the edge of the heated surface.

D. Soldering:

1. The fastening of two metals of like or unlike qualities with another metal entirely different from either or both of the base metals.
2. Used for a leakproof joint, neatness, low electric resistance, and sanitation.
3. Different solders for soldering tin, copper, brass, bronze, sheet iron, and sheet steel.
4. Solder commonly used is a lead and tin alloy.
5. Soldering flux - in powder, liquid, paste, and solid form.
6. Flux is used to clean the base suface and keep away the outside atmosphere.

E. Cut With the Carbon Arc Torch:

1. Leaves clean cut because no foreign materials are introduced.
2. Used successfully on cast iron.
3. Electrode should not extend more than 6 inches from holder when cutting.
4. Lens shade #12- #14 is recommended for both carbon arc welding and cutting.

TEACHING LEARNING ACTIVITES:

1. The teacher should discuss and demonstrate each operation using the carbon arc torch.
2. Set up examples of materials that had been bent, brazed, soldered, and cut.
3. Allow students to perform each activity.

SUGGESTED EVALUATION:

1. Grade the students work or set up a contract grading system as in lesson three "Position Welding."

LESSON 5: CARBON ARC AND METAL ELECTRODE ARC CUTTING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Set up the carbon arc equipment for cutting.
2. Make a cut using the carbon electrode.
3. Select the proper metal electrode for cutting.
4. Set up the arc welding equipment for cutting.
5. Make a cut using a metal electrode.

MOTIVATION:

The motivation of this lesson involves allowing the student the experience of performing the activities and encouragement from the teacher on each student's performance.

REFERENCES:

Modern Welding, Goodhart, Willcox Co.

Transparencies: "Cutting Metal with Shielded Arc Electrode"
"Other Uses of the Arc Welder"

OUTLINE:

A. For Safety with Cutting:

   1. Wear standard welding clothing and helmet for protection from the high intensity light and the molten metal that is being removed.
   2. For carbon arc cutting the lens in the helmet should be darker than for normal arc welding. Use shades #12-#14.
   3. Since there is more sparks and smoke there is a greater need for ventilation and fire protection.

B. Adjustments of Equipment for Carbon Arc Cutting:

1. Grind carbon electrode to a very sharp point.
2. Carbon electrode should not extend more than 6 inches beyond the holder. If carbon still wears away too fast shorten the electrode to a minimum of 3 inches outside of the holder.
3. Set welder at a high amperage. (25-50 amps. above the welding current for the same metal thickness.)

C. Making a Cut with Carbon Arc:

1. Manipulate in a verticle elliptical movement to undercut and enable the removal of the molten metal.
2. A crescent motion is then desired in continuing the cut.

D. Uses for carbon arc successful on cutting cast iron.

E. A metal electrode for cutting has covering that breaks down at a slower rate than does the metal center.

F. Equipment Set up for Cutting With Metal Electrode:

1. Use standard welding equipment.
2. Set current as high as electrode will take without over-heating and cracking the covering.

   a. 1/8 in. - 125-300 amps.
   b. 5/32 in. - 250-375 amps.
   c. 3/16 in. - 300-450 amps.

G. Metal Electrode Cutting:

1. Used to gauge a groove by holding the electrode at a 5^{0} angle or less to the plate.
2. Begin a cut by holding electrode perpindicular to make hole then slant to 85^{0} angle away from the direction of travel.

TEACHING LEARNING ACTIVITIES:

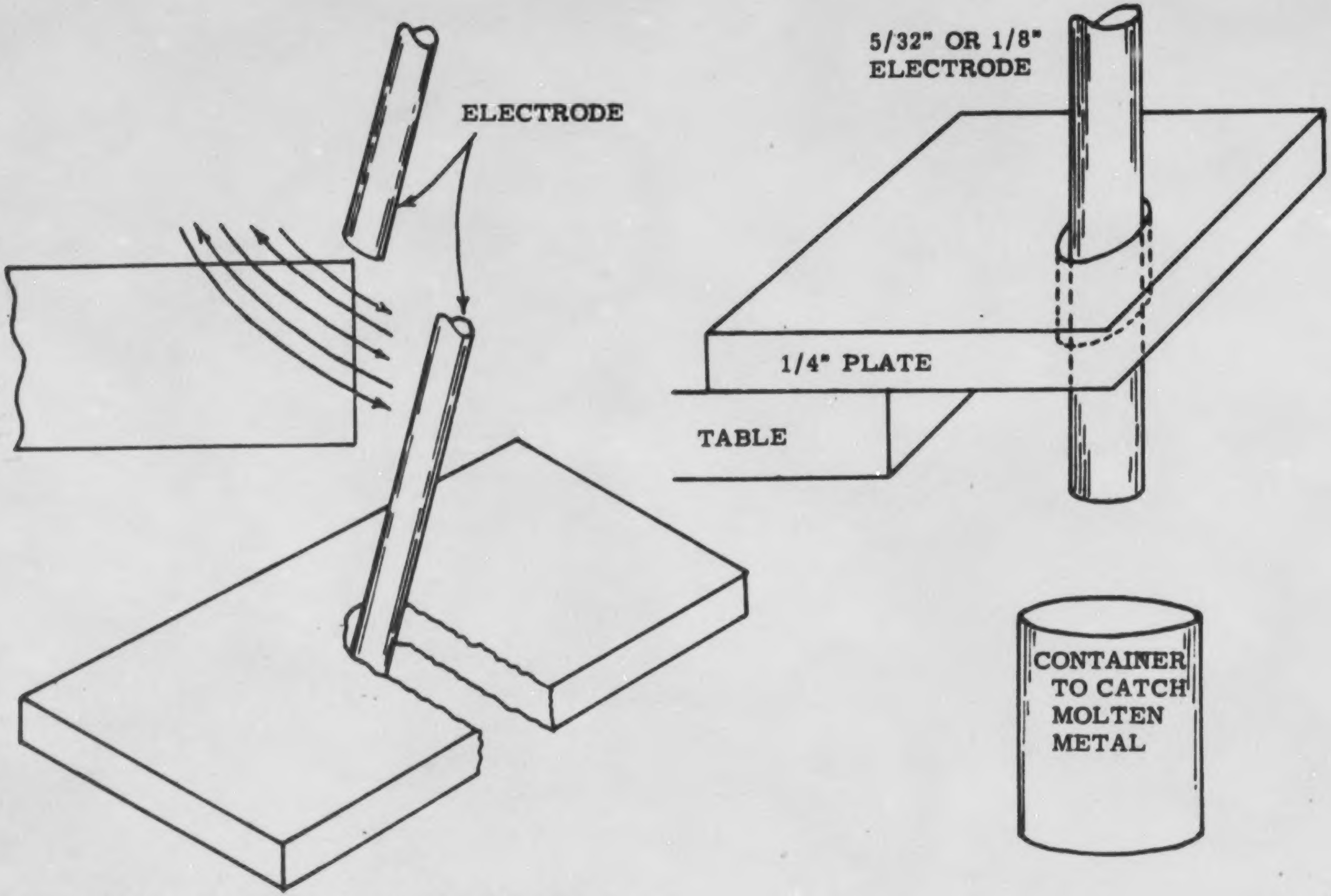
1. Review the safety procedures, the general rules of the shop, and the work area assignments.

2. Demonstrate the set up of the carbon arc equipment for cutting and show the students how to make a cut.
3. Discuss with the class the characteristics of the metal electrodes that are to be used for cutting.
4. Show and discuss the transparencies "Cutting Metal with Shielded Arc Electrode" and "Other Uses of the Arc Welder."
5. Demonstrate the set up of the cutting equipment and show the students how to make a cut.
6. Allow each student the use of the different types of cutting equipment.

SUGGESTED EVALUATION:

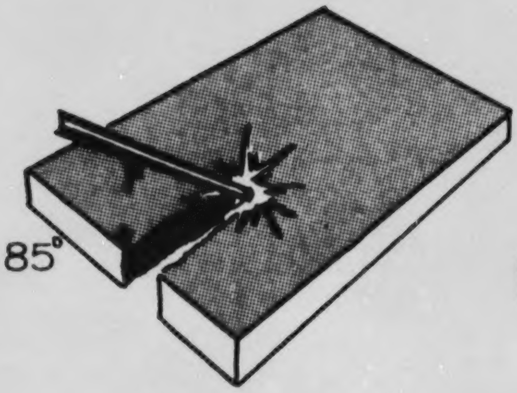
1. Evaluate the student's shop activity.

Cutting Metal with Shielded Arc Electrode

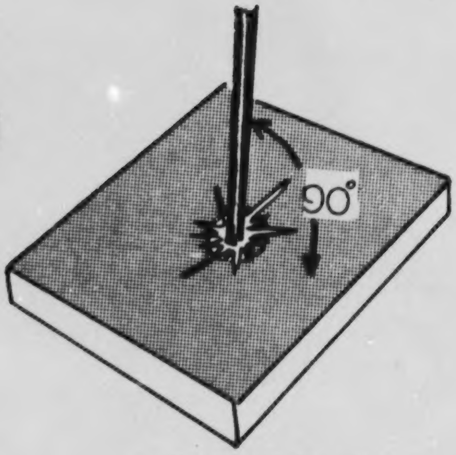

ELECTRODE
5/32" OR 1/8"
ELECTRODE
1/4" PLATE
TABLE
CONTAINER
TO CATCH
MOLTEN
METAL

Courtesy of: The Instructional Materials Laboratory
10 Industrial Education Building
University of Missouri
Columbia, Missouri 65201

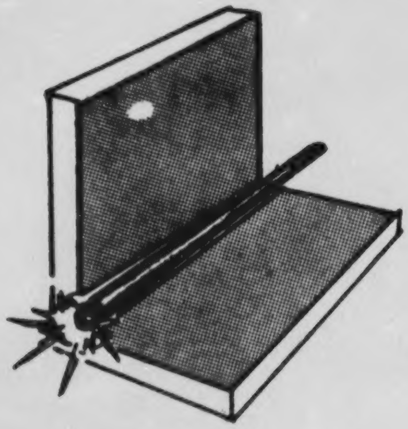
OTHER USES OF THE ARC WELDER



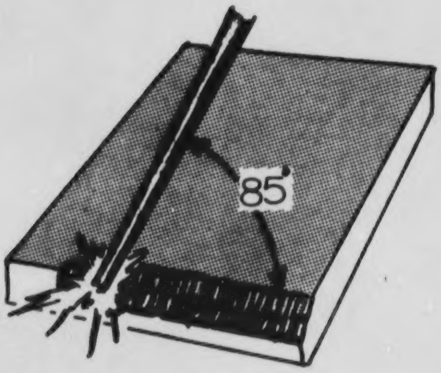
CUTTING



PIERCING



GOUGING



BEVELING

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Texas A & M University
College Station, Texas 77843

LESSON 6: CAST IRON WELDING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Describe what cast iron is and how it acts when heated.
2. Weld a practice form of cast iron.

MOTIVATION:

Each student will have a chance to learn the skill of welding cast iron.

REFERENCES:

Modern Welding; Goodhart-Wilcox Co.

Transparency: "Welding Cast Iron"

OUTLINE:

A. Properties of Cast Iron.
   1. Casting made of iron and between 2.25% and 4% carbon.
   2. Alloy metals may be added.
   3. Used for heavy machine parts.
   4. Expands and can crack at other points when heated.

B. Preparing Cast Iron for Welding
   1. Thin pieces cleaned by grinding.
   2. Thick pieces should be beveled at 30° angle for each piece (both joined equals 60° angle).

C. Preheating
   1. To prevent cracking
   2. To permit faster welding

3. Assures closer alignment of the structure after the weld is completed.

4. If using a standard metal electrode.

D. Electrodes Sometimes Used are Nickle and Copper Core Metals

1. These metals are machineable.

2. The castings do not require preheating.

3. The cooling speed doesn't have to be controlled.

E. Welding Procedure

1. Practice several beads on surface to determine correct amperage setting.

2. Lay bead in bottom of vee-joint, holding arc slightly longer than when welding mild steel.

3. Use short beads and let work cool slowly before continuing the weld.

F. Inspection of the Weld.

1. Slightly crowned without undercutting.

2. No pits or bubbles on upper or underneath surface of metal.

3. Weld width should be about three times the metal thickness.

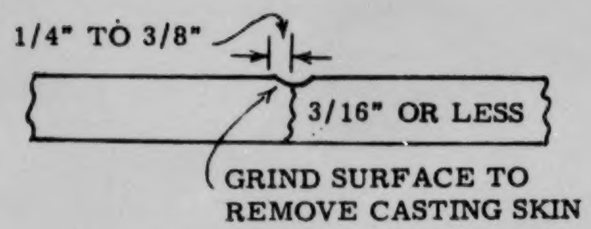
TEACHING LEARNING ACTIVITIES

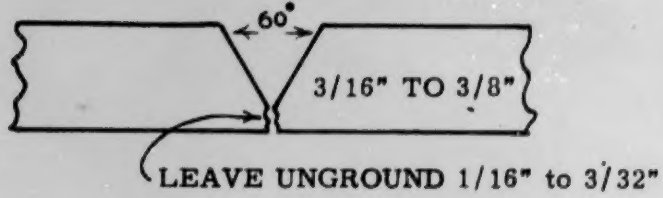
1. Discuss with the class the properties of cast iron and why a special welding technique is required. Show the transparency, "Welding Cast Iron".
2. Demonstrate how the metal should be cleaned and prepared.
3. Show the class the electrodes that are used.
4. Demonstrate how to weld cast iron.
5. Allow the students to perform the welding tasks.

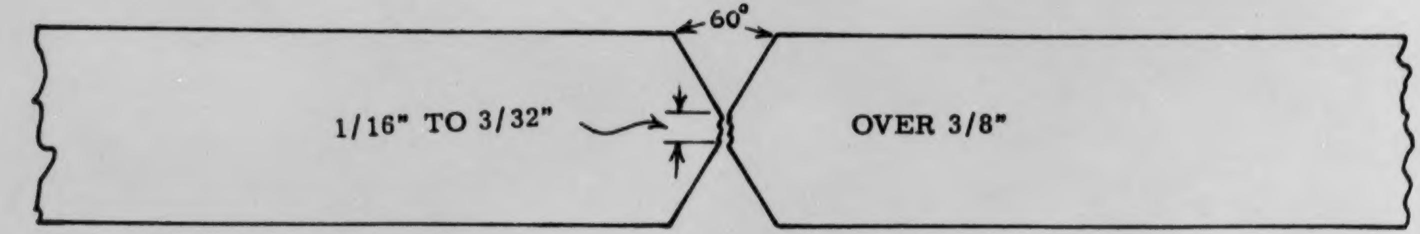
SUGGESTED EVALUATION:

1. Evaluate the students' shop activity.

Welding Cast Iron


1/4" TO 3/8"
3/16" OR LESS
GRIND SURFACE TO REMOVE CASTING SKIN


60°
3/16" TO 3/8"
LEAVE UNGROUND 1/16" to 3/32"


60°
1/16" TO 3/32"
OVER 3/8"

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10 Industrial Education Building
University of Missouri
Columbia, Missouri 65201

V-49T.

LESSON 7: PIPE WELDING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Prepare the pipe joint.
2. Set the amperage.
3. Perform roll welding.
4. Construct a welded pipe project.

MOTIVATION:

Allow students to practice pipe welding and project assembly.

REFERENCES:

Transparency: "Welding Pipe"

Project Plans: "Open Top Pipe Sawhorse"

OUTLINE:

A. Prepare Pipe Fit:
   1. Mark pipe in quarters.
   2. The portion of pipe to be removed is ground or cut away by use of the arc welding electrode.
   3. Also for corner cut two pieces of pipe on 45 degree angles.

B. Amperage Setting for a 1/8" Rod Should be Between 80 and 100.

C. Roll Welding:
   1. Strike arc on top of the pipe.
   2. The pipe is rotated keeping arc on top.

3. Hold the electrode perpendicular to pipe or slightly in the direction of travel.

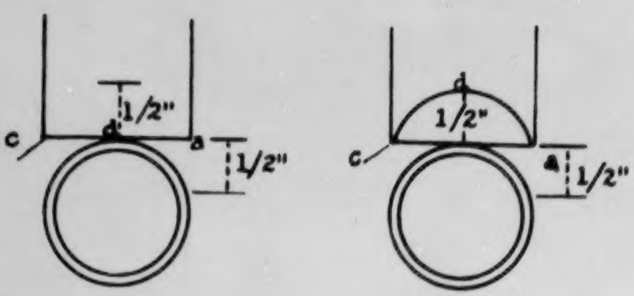
TEACHING LEARNING ACTIVITES:

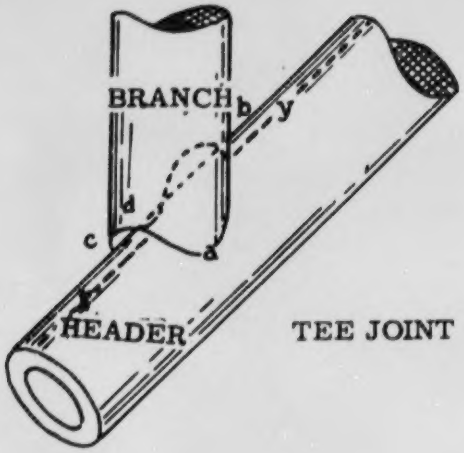
1. Discuss with the class how a pipe joint should be prepared. Show the illustration on the "Welding Pipe" transparency.
2. Demonstrate how to prepare the joints.
3. Demonstrate how to weld pipe.
4. Allow students to practice welding pipe.
5. Hand out the "Open Top Pipe Sawhorse" plans and review the construction with the class.
6. Have each student or students in groups contruct sawhorses.

SUGGESTED EVALUATION:

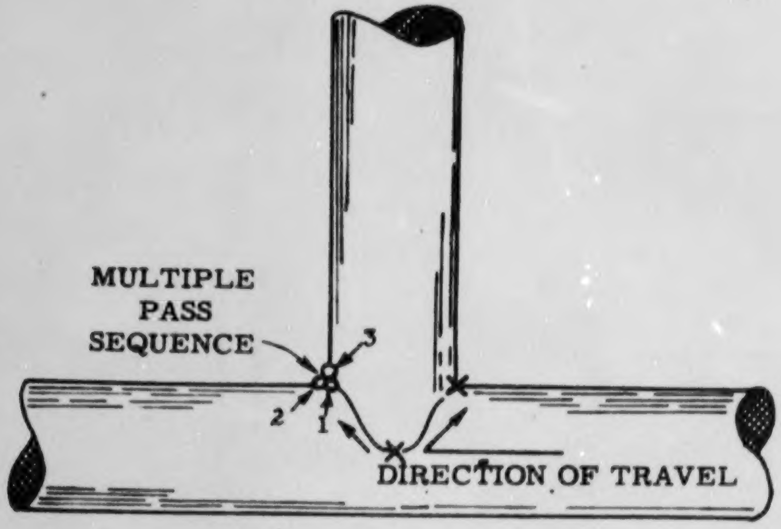
1. Evaluate the students' shop activity.
2. Assign grades to completed sawhorse.

Welding Pipe

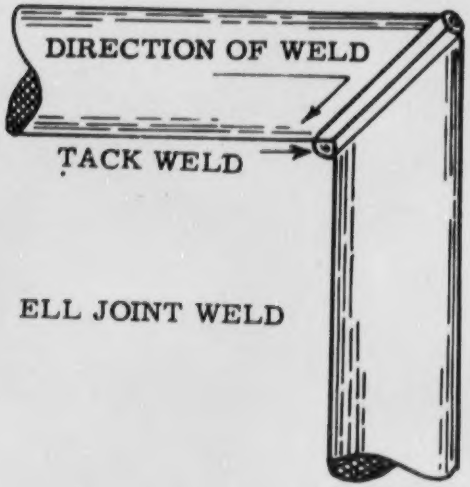

c
d
1/2"
a
1/2"
c
d
1/2"
a
1/2"


BRANCH
b
y
d
c
a
x
HEADER

TEE JOINT


MULTIPLE PASS SEQUENCE
3
2
1
DIRECTION OF TRAVEL

TEE JOINT WELD


DIRECTION OF WELD
TACK WELD

ELL JOINT WELD

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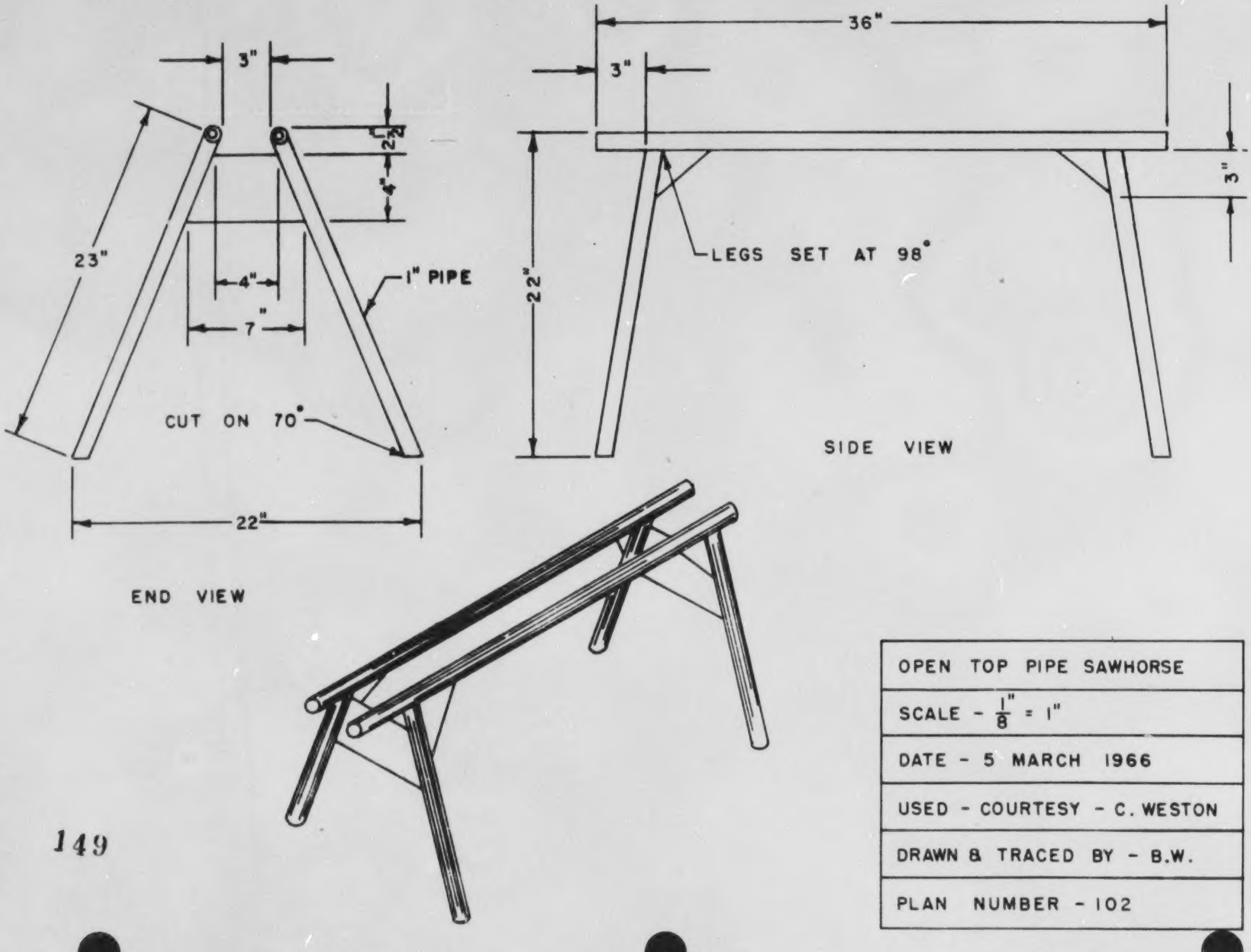
University of Missouri
Columbia, Missouri 65201

OPEN TOP PIPE SAWHORSE



3"
$2\frac{1}{2}$"
4"
23"
4"
7"
1" PIPE
CUT ON 70°
22"
END VIEW
36"
3"
22"
3"
LEGS SET AT 98°
SIDE VIEW

OPEN TOP PIPE SAWHORSE
SCALE - $\frac{1}{8}$" = 1"
DATE - 5 MARCH 1966
USED - COURTESY - C. WESTON
DRAWN & TRACED BY - B.W.
PLAN NUMBER - 102

V- 53H

Bill of Material

2 - 1" x 36" black pipe for top
4 - 1" x 23" black pipe for legs
2 - 3/16" x 3" x 3" flat metal cut for side braces
2 - 3/16" x 4" x 7" flat metal cut for end braces

Construction Procedure

1. Cut pipe to length for top and legs. It would be easier to cut two lengths of pipe 46" long and then cut in half using the 70° setting to make two legs.

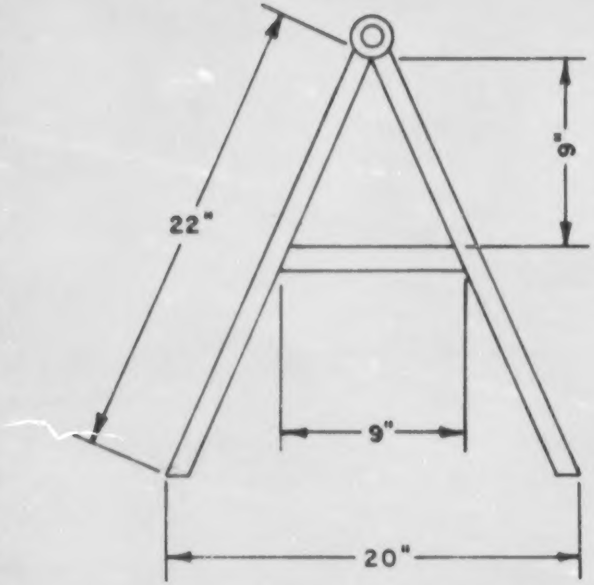
2. The top of each leg is ground to fit the 1" pipe on the top.

3. The 3/16" x 3" x 3" side braces could be made from a square piece of metal by cutting diagonally and grinding to fit the 98° angle.

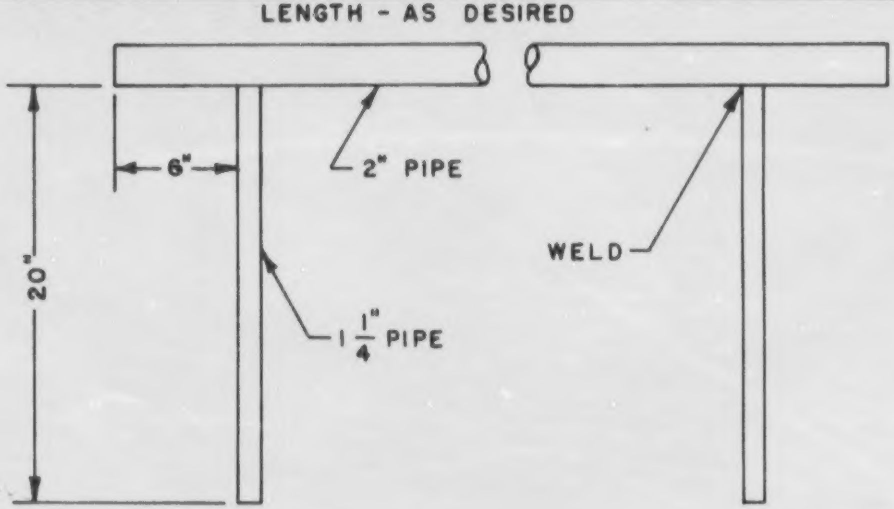
4. It would probably be wise to construct a jig to hold pipes in place for tack welding since the legs are on two angles, one when viewed from the side view and one when viewed from the end view.

5. Another suggestion would be to leave the bottom ends of the legs cut square. OR, it is possible to cut the legs 1" longer and mark the bottom angle after construction by means of a block of wood and then cut the angle after construction.

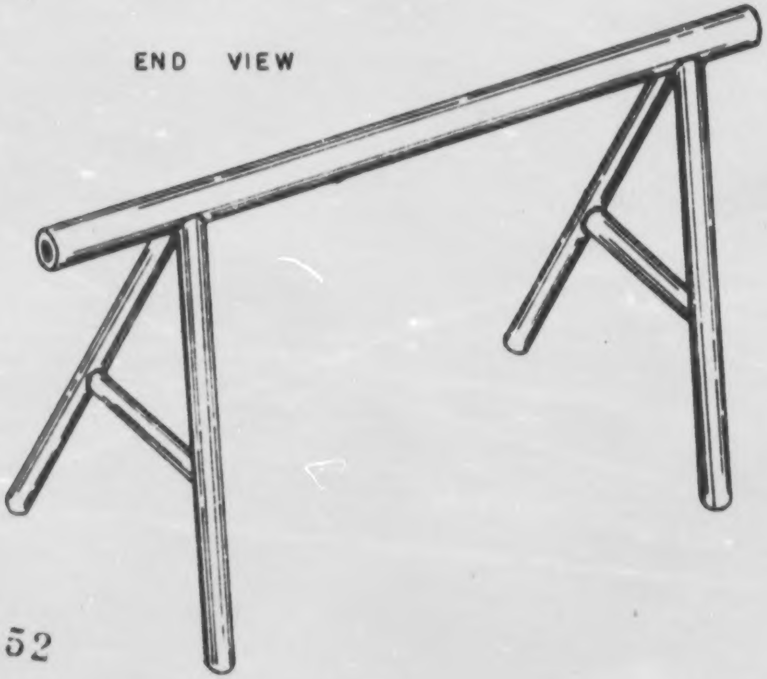
6. Clean welds and metal before painting with a rust inhibiting paint. Complete project by painting with an enamel paint.



END VIEW


LENGTH - AS DESIRED
6"
20"
2" PIPE
1 1/4" PIPE
WELD

SIDE VIEW



USE SQUARE SETTING - 12 AND 5 OR 67 1/2° ON ALL ANGLES.

PIPE SAWHORSE
SCALE - 1/8" = 1"
DATE - 6 MARCH 1966
USED - COURTESY - C. WESTON
DRAWN & TRACED BY - B.W.
PLAN NUMBER - 103

V- 55H

Bill of Material

1 - 2" black pipe to desired length
4 - 1 1/4" x 22" black pipe for legs
2 - 1 1/4" x 9" black pipe for braces

Construction Procedure

1. When sawing the legs it would be easier to cut two lengths of pipe 44" long and then saw each length in the middle to form the angle cut for the bottom of two legs. Use square setting of 5" and 12", cutting on the 5" side of the square.

2. The legs at the tops are ground to fit the 2" pipe.

3. Use a spacer to locate the legs 20" apart when viewed from the end, place 2" pipe in place on legs, square legs and tack weld.

4. Complete welding job, clean welds and metal before painting with a rust inhibiting paint. Complete project by painting with enamel.

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10 Industrial Education Building
University of Missouri
Columbia, Missouri 65201

LESSON 8: SAFETY AND OPERATION OF OXY-ACETYLENE WELDING EQUIPMENT

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List the major function of oxy-acetylene heat.
2. Identify from examples and diagrams examples of oxy-acetylene equipment.
3. List ten safety rules to observe when handling oxy-acetylene equipment.
4. Attach regulators, hoses, and torches to the tanks.
5. Set tanks and regulators at recommended openings and pressures.
6. Light the torch and adjust the flame.
7. Shut off the flame and prepare equipment for storage.
8. Clean welding tips.

MOTIVATION:

To stress the importance of safety, fill three balloons. Fill one balloon with acetylene gas, another with oxygen, and another with a small amount of oxygen and acetylene gas. Attach the balloons to ring stands and tie a string to each. Light the strings on first the gas balloon, next the oxygen balloon and finally the mixture balloon.

The first balloon will show that gas or oxygen by itself is relatively safe but when mixed is very volatile. Indicates the fire triangle of heat, fuel, and oxygen. The teacher should experiment with this in a reasonably open area before demonstrating the experiment to the class.

REFERENCES:

Modern Welding, Goodhart-Willcox Co.

Shopwork on the Farm, McGraw-Hill Book Co.

Transparency masters: "Safety Practices"
"Preparing Metal Lighting Torch"

OUTLINE:

A. Major Functions of Oxyacetylene Heat:

1. Metal is joined by the fusion process. The heated (melted) portions fuse together forming a weld. The process can be accomplished with or without the use of a welding rod.

2. The joining of metals or metal by adding bronze as a filler is known as brazing. Base metal is heated to a temperature that will cause the bronze to stick and bond the metals together.

3. Soft and hard solders (lead and silver alloys) are the filler materials in soldering. The base material is heated to a temperature that will cause the solder to stick.

4. Oxyacetylene flame is used to bend, shape, preheat, postheat, and temper metals. Heating of metals is one of the most important functions of the oxyacetylene flame.

5. The oxyacetylene flame is also important in separating metals. The metal oxidizes after a kindling temperature is attained and pure oxygen is applied to it. This practice is known as cutting or burning.

B. Oxyacetylene Welding Equipment:

1. Acetylene cylinder
2. Acetylene cylinder valve
3. Acetylene fitting
4. Acetylene regulator
5. Oxygen cylinder
6. Oxygen cylinder valve
7. Oxygen fitting
8. Oxygen regulator
9. Oxygen torch valve
10. Welding torch body
11. Acetylene torch valve
12. Welding tip
13. Welding goggles

14. Welding gloves
15. Safety chain
16. Flint lighter
17. Cylinder truck

C. Safety Rules for Handling Oxygen, Acetylene, and Oxyacetylene Welding Equipment:

1. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over.

   NOTE: Acetylene gas is in a liquid state in the cylinder and should be used in the vertical position in order that acetone will not be withdrawn.

2. Blow out cylinder valves in order to remove dust and dirt that may damage regulators.

   NOTE: Be sure to crack cylinder valves for a second before attaching regulators.

3. Release pressure adjusting screw on regulator before opening cylinder valve to prevent damage to regulator and possible injury to operator.

4. Stand to the side of regulator, keeping the cylinder valve between operator and regulator while opening cylinder valve.

5. Open cylinder valve slowly.

6. Do not use acetylene (in free state) at pressures higher than 15 psi.

   NOTE: Acetylene becomes unstable at pressures about 15 psi and becomes highly explosive.

7. Purge oxygen and acetylene passages individually before lighting torch.

8. Light acetylene before opening oxygen torch valve.

9. Never use oil or grease on regulators, torches, or fittings.

   NOTE: Oil or grease and oxygen have a very great attraction for one another and will unite with explosive violence.

10. Do not use oxygen as a substitute for compressed air.

11. Use safety goggles, gloves and protective clothing.

    NOTE: Keep gloves, hands, and clothing free from oil and grease.

12. Have CO_2 or dry powder type fire extinguisher available.

13. Test connections for leaks with soap suds, paintbrush and water.

14. Avoid lighting torch or welding near combustible material.

15. Never open the acetylene cylinder valve more than 1/2 to 3/4 turn.

16. Always operate torch in a well-ventilated place.

17. Never weld on containers that have been used for combustible materials.

18. Avoid breathing toxic fumes when welding.

    EXAMPLE: Galvanized metal

19. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves.

20. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on equipment.

21. Turn off acetylene torch valve first in order that the flame will go out immediately.

22. Never cut or weld near concrete. (within 2-3 inches)

23. Always weld or cut at least five feet from cylinder.

24. Always protect hoses from hot metal, rupture or mechanical damage.

25. Always light torch with friction lighter.

26. Never leave a burning torch unattended.

D. Equipment Set-Up:

1. Attach regulators to cylinders:
   a. Firmly tighten regulator nuts
   b. The regulator screw set for the out position

2. Connect the oxygen hose (green) to oxygen regulator outlet.
   a. Has right hand thread connection
   b. Turn regulator adjusting screw clockwise until a reading of 5 pounds shows on the gauge. Turn adjusting screw counter clockwise to turn off oxygen.
   c. Let oxygen escape to clean hose.

3. Connect acetylene hose (red).
    a. Has left handed thread connection
    b. Blow out hose in same manner as oxygen hose
    c. Keep away from flame and the body
    d. Leave T-wrench on valve always for quick shut off
4. Connect free ends of hoses to the torch body.
    a. Oxygen - right hand threads
    b. Acetylene - left hand threads
5. Open oxygen cylinder slowly until high pressure indicator reads 2,000 psi if the cylinder is full.
    a. Never stand directly in front of regulator when valve is being opened
    b. After full pressure is reached the oxygen valve should be fully opened
6. Connect acetylene regulator same as oxygen regulator, only open a maximum of (no more than) one turn.

E. Setting the Pressure:

1. Open oxygen valve and turning pressure regulator to desired working pressure.
2. Open acetylene and turning pressure regulator to desired working pressure, do not exceed 15 psi on pressure. Working pressure usually set from 1 to 7 psi.

F. Lighting the Torch:

1. Hold the torch in one hand and friction lighter in the other.
2. Open the torch acetylene valve about 1/8 to 1/4 turn with tip pointed away from body.
3. Hold lighter one inch from the point of the tip when lighting.
4. Open acetylene valve until flame stops excessive smoking and breaks away from tip about 1/8 inch.
5. Reduce flame slightly to bring it back to tip.
6. Open the valve again very slightly.
7. Open oxygen valve until a sharp inner cone appears.

G. Turn Off the Torch:

1. Close acetylene valve at the torch.
2. Close oxygen valve at the torch.
3. Close acetylene and oxygen cylinder valves.
4. Open oxygen torch valve to clear line and reclose.
5. Open acetylene torch valve to clear line and reclose.
6. The acetylene and oxygen regulator adjusting screws are backed out until they are loose.

H. Welding Tip Care:

1. Rub tips with emery cloth or steel wool to remove metal and waste material.
2. Tip cleaners should be used to clean the tip opening. The cleaner should have the same number as the tip.
3. If the oxygen valve is opened slightly while the cleaner is carefully pushed in and pulled out of the opening, will blow out loosened particles.
4. Store tips in a rack for protection.
5. Replace tips by hand. If a wrench is needed not overtighten.
6. Tips are easily cross-threaded when attached so care should be taken.

TEACHING LEARNING ACTIVITIES:

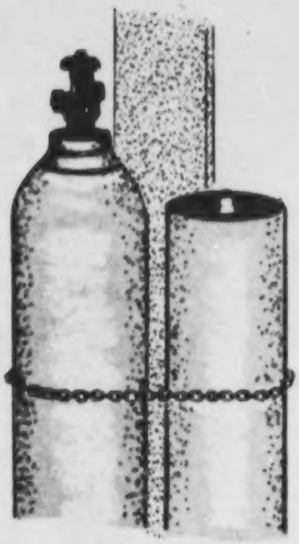
1. Discuss with class the uses of oxyacetylene welding.
2. Show the transparency of equipment and take students to the shop to view the equipment.
3. Give each student a list of safety procedures to observe when using oxyacetylene equipment. Review this list with the class.
4. Demonstrate to the class the methods used to set up the equipment. Select students to demonstrate the procedures.
5. Discuss and demonstrate how valves and regulators are to be adjusted.
6. Demonstrate how to light the torch, adjust the flame, and shut down the equipment for storage.

7. Have students practice the demonstrated procedures.
8. Discuss the importance of keeping welding tips clean.
9. Show the class how to clean welding tips.

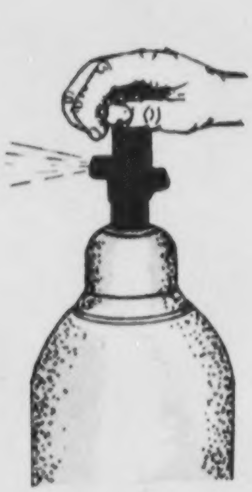
SUGGESTED EVALUATION:

1. Provide a written quiz made up of questions from the lesson objectives.
2. Evaluate students' shop activities.

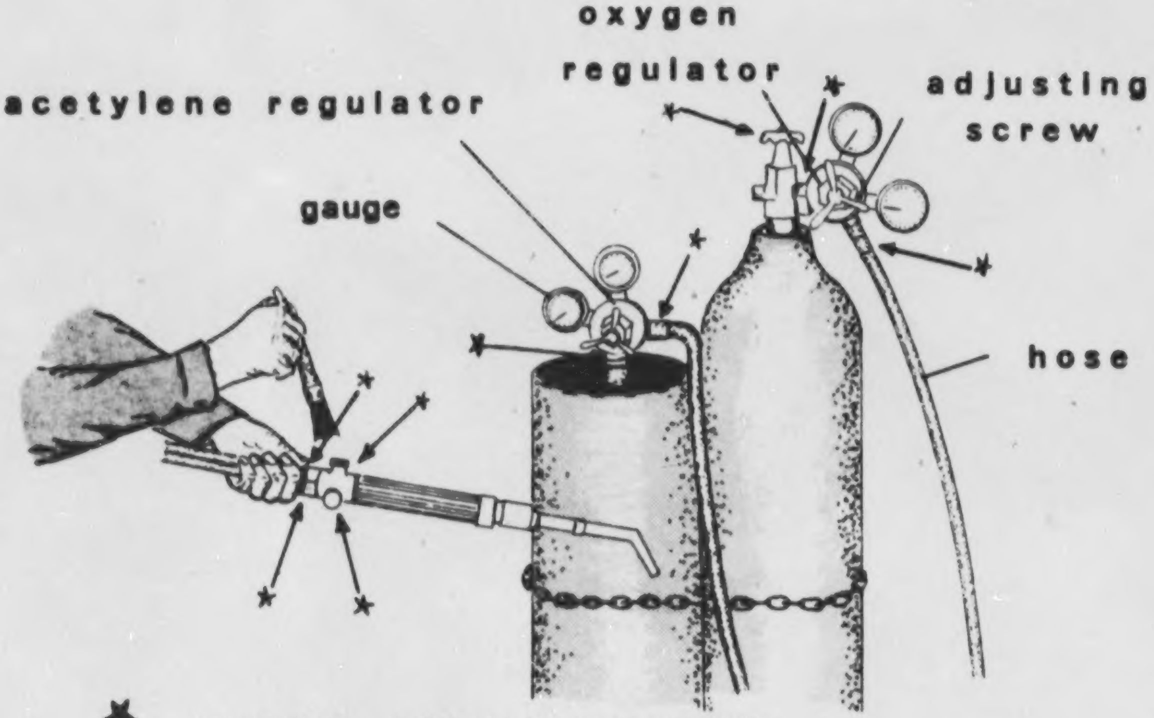
SAFETY PRACTICES



CYLINDERS SECURED BY CHAIN



FOREIGN MATTER BLOWN FROM CYLINDER VALVE

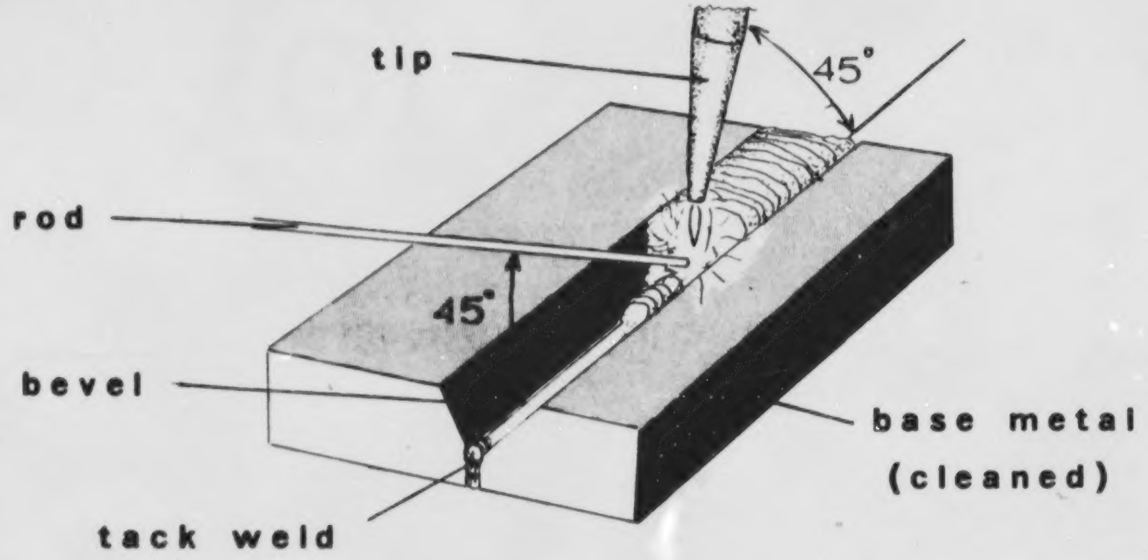

oxygen regulator
acetylene regulator
adjusting screw
gauge
hose
*
*
*
*
*
*
*
*
*

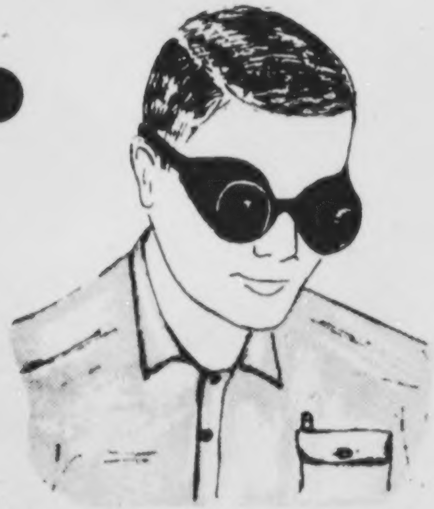
* LEAK AREAS TESTED WITH SOAP AND WATER

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

V-65T

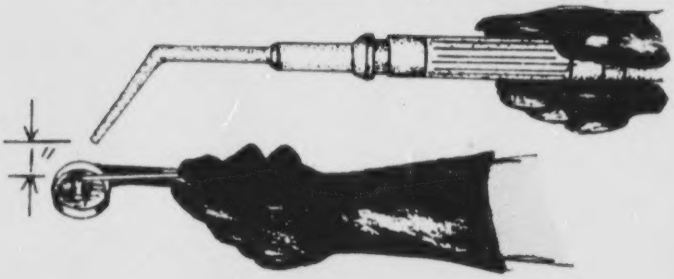
PREPARING METAL LIGHTING TORCH

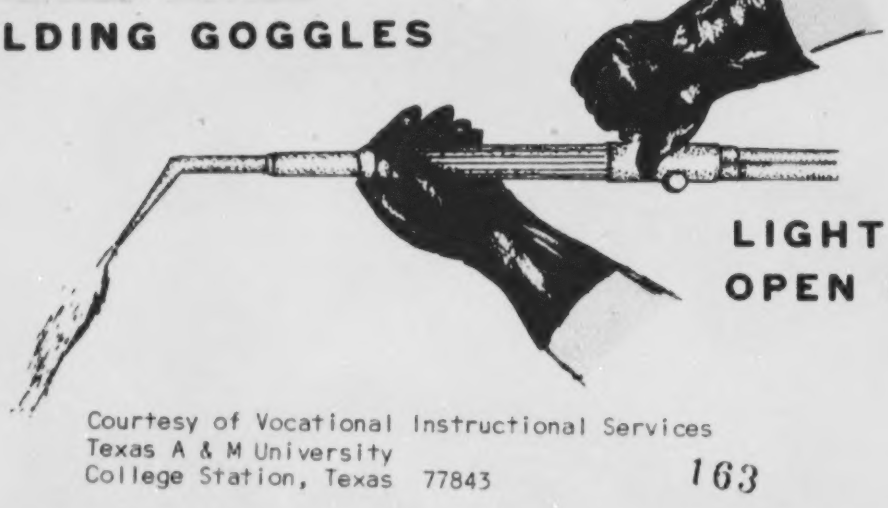

tip
45°
rod
45°
bevel
base metal
(cleaned)
tack weld



WELDING GOGGLES

LIGHTING TORCH





LIGHT ACETYLENE
OPEN OXYGEN

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

LESSON 9: WELDING WITH THE OXYACETYLENE TORCH

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Adjust the torch to the three types of flames used in oxyacetylene work.
2. Select the proper size welding tip and rod for certain metal thickness.
3. List factors that determine weld quality.
4. Form a puddle and run a bead on gauge metal.
5. Identify properties of a strong weld from examples.
6. Construct a corner weld without filler rod.
7. Lay beads on gauge metal with a filler rod.
8. Weld butt joints with a filler rod.

MOTIVATION:

To allow students to get direct experience in welding provides motivation to participate in welding activities.

REFERENCES:

Modern Welding, Goodhart Willcox Co.

Shopwork on the Farm, McGraw-Hill Book Co.

Transparency: "Kinds of Welding Flames"

OUTLINE:

A. Three Types of Flames:

   1. Neutral Flame - flame has a sharp inner cone.

2. Carburizing flame - excess acetylene has an inner cone and an acetylene feather - largest flame.

3. Oxidizing flame - excess oxygen - inner cone has a sharp point and main flame body smaller than other two types of flames - used for brazing.

B. Size of Welding Tip and Size of Rod for Thicknesses of Metal:

Tip Size (Orifice)	Rod Size (Inches)	Thickness of Metal (Inches)
74	1/16	1/32
69	1/16	1/16
64	3/32	3/32
57	1/8	1/8
55	3/16	3/16
52	3/16	1/4
49	1/4	5/16
45	1/4	3/8
42	1/4	1/2

C. Factors that Determine Weld Quality:

1. Proper flame adjustment.

2. Angle of tip.

3. Distance from work.

4. Speed of travel.

5. Movement of tip.

D. Oxyacetylene Welding Procedures:

1. The flame should be directed at the starting point to start the puddle. The puddle will appear as a bright round pool of molten metal.

2. Puddle width is determined by the depth of penetration and motion of the torch. If a 3/16 inch puddle is formed, the speed of welding should maintain that width.

3. If the speed is correct, the puddle will be formed under the inner cone of the flame. Usually, the inner cone is held from 1/16 to 1/8 inch above the surface. If the speed is too slow, the torch flame will burn a hole through the metal or form a large puddle. If the speed is too fast, the bead will be irregular and narrow.

4. There are several types of torch movement patterns, but the most common pattern for an inexperienced welder is the circular motion. A weaving or zigzag pattern is a very common motion to use.

E. Properties of Good Weld:

1. Consistent width.

2. Straightness.

3. Slightly crowned.

4. Fused into base metal.

5. Clean appearance.

F. Running a bead

1. Use a mild steel 16 gauge strip, 1 1/4" x 6".

2. Turn on unit, light, and adjust torch.

3. Place inner cone 1/16" - 1/4" from base metal.

4. Establish a molted puddle.

5. Position torch 30° - 45° from verticle in direction of travel.

6. Slowly move the torch forward allowing metal to melt.

7. Repeat process.

G. Corner Weld

1. Use two strips of metal same as in F.

2. Place the metal in an up-side-down V position.

3. Turn on unit, light, and adjust torch.

4. Tack weld the base metal in position.

5. Place inner cone 1/16" - 1/8" from base metal

6. Establish a molten puddle

7. Begin welding from the right end.

8. Hold tip vertically at 45° angle from direction of travel.

H. Weld a bead using filler rod

1. Use same type of steel strip as in F and a mild steel filler rod.
2. Turn on unit, light, and adjust flame.
3. Hold torch 30° - 45° from center.
4. Add filler rod to front edge of puddle to form in base metal.
5. Maintain puddles size and shape for length of bead.

I. Butt joint with filler rod.

1. Use same beginning procedures as in other welding.
2. Place the metal parallel and tack base metal together at both ends.
3. Maintain torch at a 30° - 45° angle away from direction of travel.
4. Maintain rod at 30° - 45° angle with direct of travel
5. Move puddle forward with torch and add rod to front edge of puddle to form in base metal.

TEACHING LEARNING ACTIVITIES:

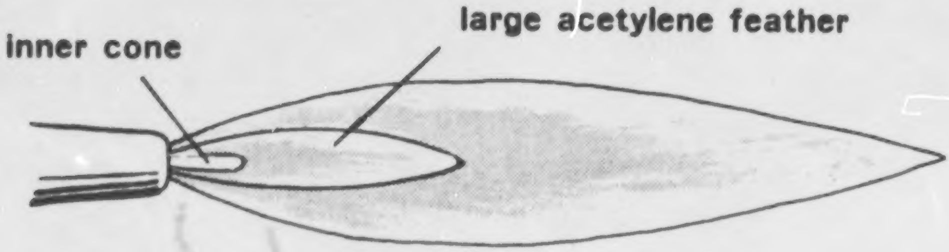
1. Set up the equipment and demonstrate the adjustment for the three types of flames.
2. Provide information on tip sizes and rod sizes to use for different metal thicknesses.
3. Discuss the factors that can determine a good weld. Ask students why these factors are important.
4. Demonstrate the procedure for running a bead with the torch.
5. Show examples of welds. Ask which example is the best weld and why.
6. Assign each student the task of running a bead. Review the outline with each student before they begin.
7. Demonstrate the procedure for constructing a corner weld.

8. Review the outline and have each student construct a corner weld.
9. Demonstrate the use of a filler rod in laying beads.
10. Review the outline and have each student demonstrate this procedure.
11. Review the outline on welding butt joints.
12. Select a student to demonstrate the procedure for the class. Correct errors while demonstration is being performed. Assign each student to weld a butt joint.

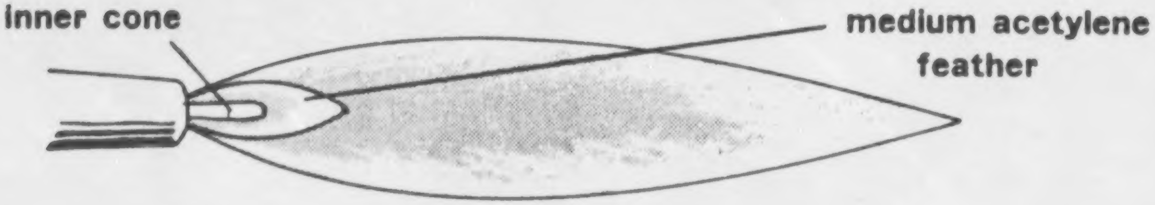
SUGGESTED EVALUATION:

1. A lab practicle arranged to allow students to identify types of flames, judge quality of welds, and do one of the practiced welds.
2. Evaluation of students' shop activities.

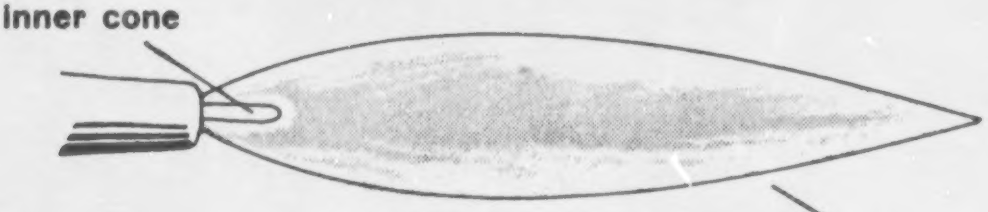
KINDS OF WELDING FLAMES


large acetylene feather
inner cone

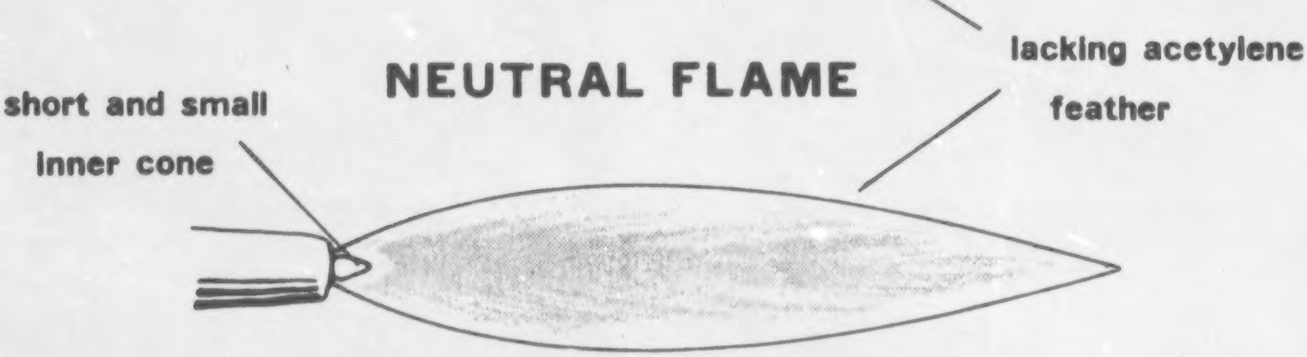
CARBURIZING FLAME


inner cone
medium acetylene feather

FLAME BETWEEN CARBURIZING AND NEUTRAL



NEUTRAL FLAME


lacking acetylene feather
short and small inner cone

OXIDIZING FLAME

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

LESSON 10: CUTTING WITH THE OXYACETYLENE TORCH

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Describe the process by which metal is cut with a cutting torch.
2. Identify the parts of the torch body and cutting attachment from diagrams and examples.
3. List four causes of a backfire.
4. Describe the results when a backfire takes place and when a flashback takes place.
5. Describe the qualities of sample cuts giving reasons for a poor cut.
6. Lay out a pattern on metal to be cut.
7. Make ninety degree cuts and restart a cut.
8. Make a flame beveled cut.
9. Cut a hole in mild steel.

MOTIVATION:

Set up the equipment for cutting. Demonstrate the cutting technique. Ask students how the metal is cut with a torch. Why is the oxygen cutting lever needed.

REFERENCES:

Modern Welding, Goodhart-Willcox Co.

Shopwork on the Farm, McGraw-Hill Book Co.

OUTLINE:

A. Cutting Process:

1. Metal is preheated to cherry red color.
2. When metal reaches cherry red color pure oxygen is added.
3. Oxygen chemically combines with the metal causing oxydation to take place. (Examples of oxides are rust or corrosion.)
4. The chemical reaction produces heat but usually doesn't give off enough heat to continue the cutting process.
5. The preheat flames are kept burning to provide the additional heat.

B. Parts of Torch Body and Cutting Attachment (see transparency master)

C. Causes of Backfire:

1. Insufficient acetylene or oxygen pressure.
2. Loose cutting tip.
3. Dirty tip.
4. Overheating of cutting tip.
5. Bad O-ring in torch body.

D. Results of a Backfire:

1. Flame burns momentarily back into tip.
2. A loud snap or pop results:
    a. Flame may go out
    b. Flame may continue to burn in normal manner

E. Results of Flashback:

1. Fire inside torch.

2. Disappearance of flame followed by:
    a. Squealing or hissing noise inside torch
    b. Sparks coming from the torch
    c. Smoke coming from the torch

F. Steps to Follow in Case of Flashback:

1. Close oxygen preheat valve.
2. Close oxygen torch valve.
3. Close acetylene torch valve.
4. Release oxygen regulator screw.
5. Release acetylene regulator screw.
6. Examine acetylene unit.
7. Reset regulator pressures.
8. Light torch.

G. Reasons for Poor Cut:

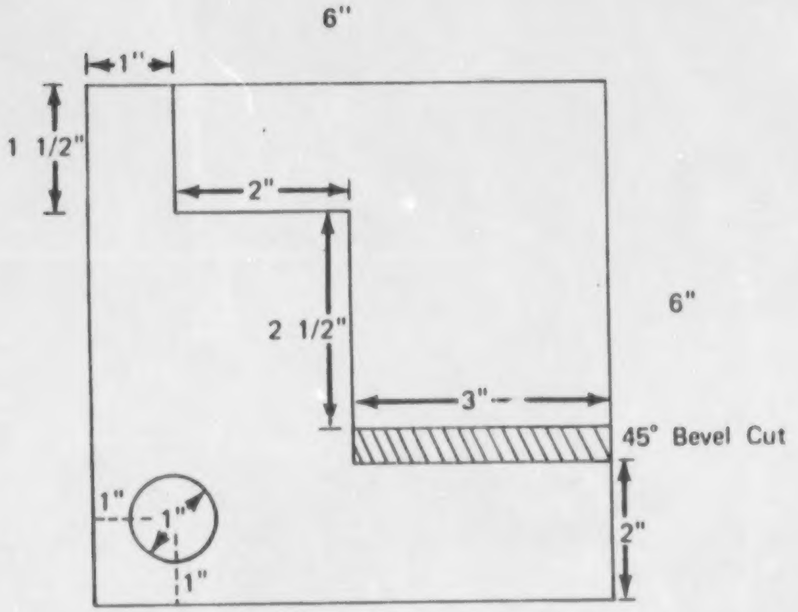
1. Preheat flames too small causing gouging at bottom of cut.
2. Preheat flames too long - top surface melted over, the cut edge is irregular, excessive amount of adhering slag.
3. Oxygen pressure too high - control of cut is lost.
4. Oxygen pressure too low - top edge melted due to cutting speed too low.
5. Cutting speed too slow - some of the perpendicular lines are drag lines or much more pronounced than others.
6. Cutting speed too high - cut edge is irregular and curvature and break to the drag line exists.
7. Cut was lost and not carefully restarted leaving bad gouges at restarting point.
8. Torch travel unsteady - cut edge is wavy and irregular.

H. Making a cutting pattern

1. Use a square, straight edge. soapstone, and a mild steel plate 1/4" - 1/2" thick, 6" square.

2. Measure distances and mark.

EXAMPLE



I. Ninety degree cut

1. Mark four parellel lines 2" apart on mild steel
2. Adjust equipment
3. Maneuvery loses with both hands
4. Hold preheat flame inner cone tip 1/16" - 1/4" from plate until plate is red hot.
5. Depress oxygen cutting lever and move from right to left. (left-handed, from left to right)
6. Hold tip at right angle to cut
7. Cool metal in can of water

J. Restart cut

1. Release oxygen cutting lever
2. Preheat edge where cut was stopped
3. Slowly depress culling lever and continue.

K. Beveled cut

1. Place 1/2", 2" x 6" plate on slag box.
2. Adjust cutting flame
3. Hold torch with both hands at desired angle to metal
4. Hold preheat flame inner cone at same level as in outline I.
5. Depress cutting lever and proceed across plate.

L. Cutting a hold

1. Draw 1" and 1/2" circles on one piece of metal.
2. Hold tip of inner cone 1/16" - 1/8" above point to be cut until it turns bright red.
3. Tilt torch 15° from verticle position and depress cutting lever slowly moving torch backwards until cut pierces the plate.
4. Move torch back to verticle and raise until inner cone is 1/4" - 1/2" above plate and make the cut.

TEACHING LEARNING ACTIVITIES:

1. Discuss from motivation how the cutting process takes place.
2. Have students on a pretest identify the parts of the torch body and cutting attachment. Review answers from the quiz.
3. Explain what backfire and flashback is to the class.
4. Ask the students for suggestions on what causes backfire. Ask what procedure should be followed when backfire or flashback occurs.
5. Show samples of cuts. Point out poor cuts and good cuts. Explain why particular cuts were poor.
6. Hand out the outline for equipment for developing a cutting pattern. Have each student lay out a pattern.
7. Demonstrate making a cut and have each student practice making 90 degree cuts.
8. Demonstrate making a flame beveled cut and have each student perform this cut.
9. Review the outline for making a hole and have students practice cutting holes.

SUGGESTED EVALUATION:

1. Assign grades to lesson activities each student completes.
2. Have the students make the cuts on their cutting pattern and grade their cuts.

LESSON 11: BRAZING WITH THE OXYACETYLENE TORCH

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write a definition for braze welding and tinning.
2. Define the purpose of flux in a short written statement.
3. List four advantages and four disadvantages for brazing.
4. Bronze weld a butt joint.

MOTIVATION:

Demonstrate bronze welding to show how easy the process is to perform.

REFERENCES:

Modern Welding, Goodhart-Willcox Co.

Shopwork on the Farm, McGraw-Hill Book Co.

TRANSPARENCY MASTER: "Bronze Welding"

OUTLINE:

A. Definitions for Braze Welding and Tinning:

   1. Braze welding - depositing a bead with a bronze welding rod on base metal heated to a dull red color. (base metal is not melted)
   2. Tinning - melting a small amount of bronze rod on the surface of base metal and spreading it along the joint that is being brazed.

B. Purposes of Flux:

   1. Chemically cleans the base metal.
   2. Increases flow of filler material.

3. Prevents oxidation of filler material.
4. Increase adherence of filler material.
5. Permits filler material to penetrate pores of base metal.
6. Floats out oxides present on base metal.

C. Advantages for Using Bronze Welding:

1. Provides less chance of destroying main characteristics of base metal since it is not heated to a molten condition.
2. Consumes less gas.
3. Can be used on thin metals.
4. Used on malleable castings.
5. Increases speed of joining metals.
6. May be used to join different kinds of metals.

D. Disadvantages for Using Bronze Welding:

1. Cannot be used on metal where stress is a factor.
2. Bronze rod is expensive to use.
3. Not recommended for parts which are raised to temperatures higher than the melting point of bronze, either in service or during heat treatment.

E. Tinning - Proper tinning is very important when welding cast iron. A thin layer of the bronze metal adheres to the case iron forming a footing for the succeeding weld.

1. Heat base metal to dull red.
2. Heat bronze in a small amount allowing it to flow in the heated area.

F. Brazing

1. Preheat end at brazing rod and dip in flux or use a fluxed rod.
2. Tack metal plates together using braze filler metal.
3. Heat the weld surface area.
4. Hold torch and brazing rod in same positions as standard welding.
5. When a cherry red color occurs melt small amount of bronze rod onto surface to allow it to spread over seam.
6. Start depositing the proper size bead when base metal is tinned.
7. Complete weld.

TEACHING LEARNING ACTIVITIES:

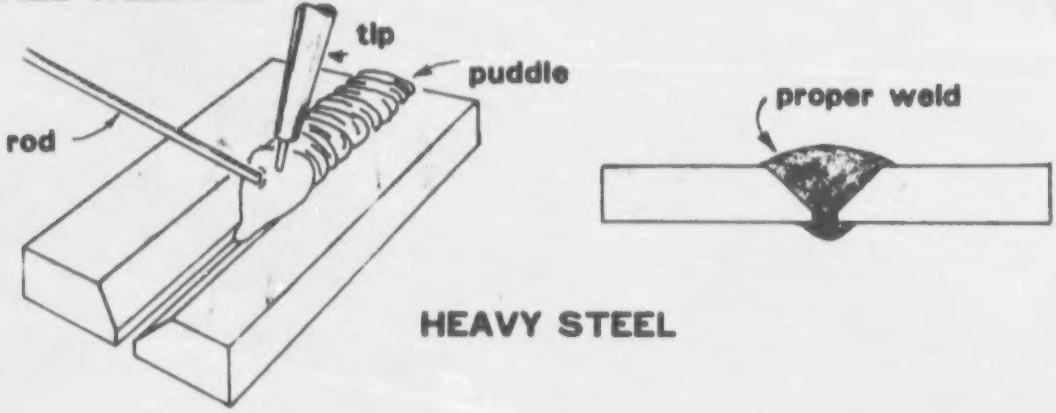
1. Ask the class what brazing means.
2. Write on the chalkboard the word "flux". Tell the students to refer to the arc welding lesson for the reasons for using flux. Ask if flux is also needed in brazing and why.
3. Have students write advantages and disadvantages they might think of for using bronze welding.
4. Demonstrate the brazing or bronze welding procedure and allow each student to practice brazing a butt joint.

SUGGESTED EVALUATION:

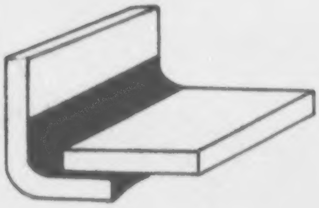
1. Short quiz on definitions and advantages and disadvantages for brazing.
2. Assign grades to each students' shop activities.

BRONZE WELDING

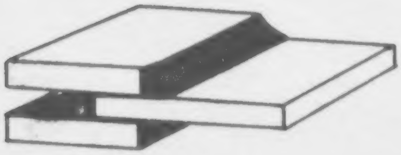
BRONZE WELDING:


tip
puddle
rod
proper weld

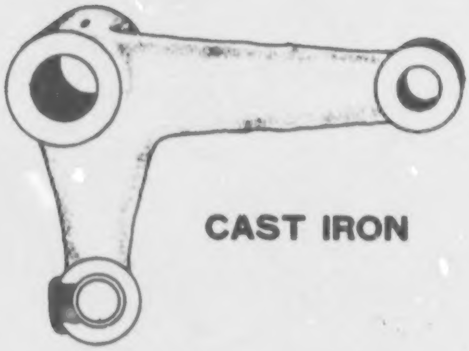
HEAVY STEEL



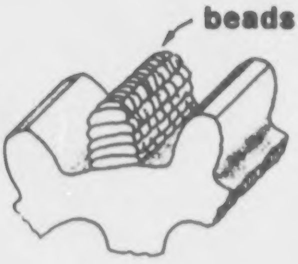
FLANGED BOTTOM



DOUBLE LAP



CAST IRON



TOOTH IN GEAR

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

LESSON 12: HARD-SURFACING WITH THE OXYACETYLENE TORCH

OBJECTIVES: At the completion of the lesson the student will be able to:

1. Write a brief statement on the purposes for hard-surfacing.
2. List advantages for using the oxyacetylene torch for hard-surfacing.
3. List the steps needed to prepare metal for hard-surfacing.
4. Demonstrate the procedure for hard-surfacing on a practice piece of metal.

MOTIVATION:

Display some material that has been hard-surfaced and some worn material. Explain how hard-surfacing can increase the life of tools and so can save expense in replacing the parts.

REFERENCES:

Modern Welding, Goodhart-Willcox Co.

Shopwork on the Farm, McGraw-Hill Book Co.

OUTLINE:

A. Purposes for Hard-Surfacing:

   1. To save money on replacing worn parts.
   2. Maintenance of sharp edges on cutting tools.
   3. Hard-surfacing alloys are usually applied on only one side - the softer steel wears away faster than the hard alloy making the part self-sharpening.

B. Advantages of Using Oxyacetylene for Hard-Surfacing:

   1. Used where a surface is to be applied and will require a minimum of final surface finishing.
   2. The carburizing flame adds carbon to the surface improving the abrasive resistance of the metal.

3. Preheating and postheating can be controlled to prevent cracking of surfacing material.

4. Well adapted to using paste hard-surfacing materials.

C. Metal Preparation:

1. Clean metal with brush to remove loose particles.

2. Grind to thoroughly clean the metal area to be surfaced.

3. Preheat the metal to eliminate warping.

D. Methods Used for Hard-Surfacing:

1. Adjust torch to a lightly carburizing flame.

2. The angles of the tip and hard-surfacing rod are held the same as when welding.

3. Heat the surface until it starts to melt or "sweat".

4. Bring the hard-surfacing rod down to the work when the metal begins to sweat.

5. The alloy from the rod will flow out in an even, thin surface.

6. The manipulations of torch and rod are very similar to the brazing techniques.

7. Allow the hard-surfaced parts to cool slowly to prevent cracking of the surfacing alloy.

TEACHING LEARNING ACTIVITIES:

1. Discuss the reasons for using hard-surfacing on equipment.

2. Ask the class what advantages oxyacetylene hard-surfacing would have over other welding processes.

3. Ask the students what should be done to the metal to prepare it for hard-surfacing.

4. Demonstrate hard-surfacing for the class.

5. Have each student hard-surface a sample or scrap metal.

6. Have students bring in any materials that they need to rebuild or hard-surface to work on during this lesson.

SUGGESTED EVALUATION:

1. Evaluate students' shop activities.
2. Quiz students over discussion material from lesson.

LESSON 13: METAL IDENTIFICATION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Identify common types of metals from samples, uses, and from spark identification.

MOTIVATION:

Give a pretest on metal identification. See how many of the metals a student can get right by looking at it.

REFERENCES:

Transparencies: "Spark Identification on High Speed Grinder"
"Standard Steel Shapes

OUTLINE:

A. Irons

1. Cast iron types.
   a. Gray
   b. White
   c. Malleable
2. Cast iron properties.
   a. Very brittle
   b. Contains large amounts of carbon and some impurities.
3. Uses of cast iron.
   a. Gray cast used to make engine bases and blocks.
   b. White cast is used for bearings, plow shares, and moldboards.
   c. Malleable cast is used for small machinery parts, pipe fittings and some machine guards.
4. Wrought iron properties.
   a. Few impurities.
   b. Low in carbon content.

5. Uses of wrought iron. To make nails, wire, bolts, pipe, scrap iron, chains, and rivets.

B. Steel

1. Mild steel

   a. Soft steel with low carbon content.
   b. Easily sawed, hammered, filed, or ground, welded, or bent.
   c. Used to make trusses, braces, and machinery bolts.

2. Machinery steel

   a. Has higher carbon content than mild steel.
   b. Used to make machinery parts (plows, beams, braces, shafts, and some axles)

3. Tool steel

   a. High carbon content
   b. Used to make cutting tools, hammers, taps, and dies.
   c. Almost free of impurities and sometimes is difficult to weld due to a high carbon content.

4. Alloy steel

   a. Other metals (chromium, silicon, nickel, manganese, tungsten, and copper) added to steel to give certain characteristics.
   b. Stainless steel - from chromium and steel and possibly nickel.
   c. High speed drill bits contain tungsten
   d. Chromium, nickel, and copper added to steel adds corrosion resisting properties.

5. Nonferrous metals

   a. Aluminum; for building sidings, roofing, casting in motors, wire, conductors in electrical work.
   b. Copper; plumbing and electrical work.
   c. Lead and tin; non-corrosive, used for pipe and soldering
   d. Zinc - base metals; used for plating (galvanizing), electric tools, fuel parts on engines.
   e. Magnesium; used in incendiary bombs, ladders, and for chain saws.
   f. Tin; coat cans, utensils, and metal roofing.
   g. Bronze; alloy of copper and zinc or tin, machine bearings, medals, bells, propellers, and statues.
   h. Brass; alloy of copper and zinc; 60-90% copper, 10-40% zinc, used for musical instruments, house hardware, and small gears.

C. Shapes of Metal

1. Angle Iron - standard length 20 feet
2. Channel Iron - standard length 20 feet
3. "I" beam - standard length 20 feet
4. "H" beam - standard length 20 feet
5. Plate or sheet - 6', 8', 10', and 12' lengths
6. Flat stock (strip)
7. Round stock
8. Rectangular tubing (box tubing)
9. Pipe or tubing

D. Identify Metal by Spark Identification (see transparency).

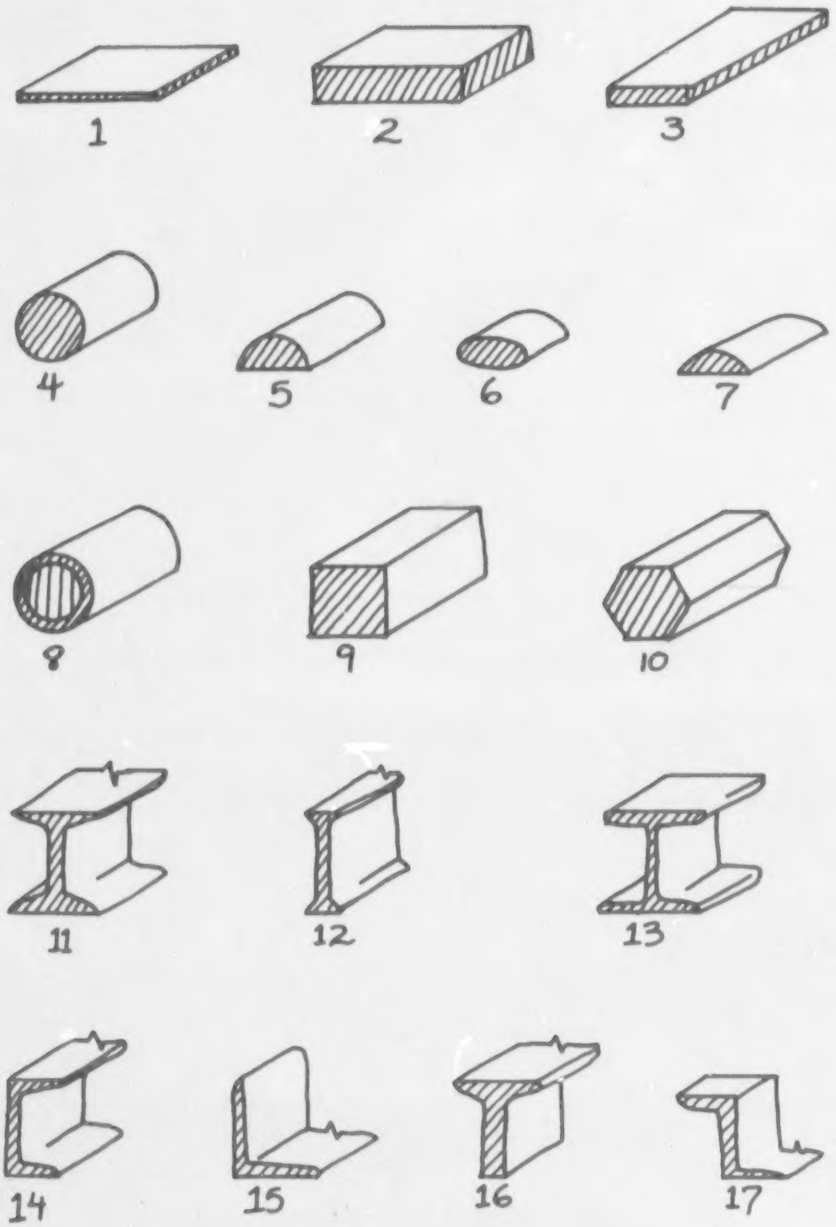
TEACHING LEARNING ACTIVITIES:

1. Allow students to review the pretest and identify the samples.
2. Discuss the uses of each type of metal with the class.
3. Allow students time to look at shapes of metal and identify the shapes. Show and discuss the transparency on shapes of metal.
4. Show the transparency on spark identification and by using samples demonstrate how sparks can be identified.

SUGGESTED EVALUATION;

1. Set up the samples including one or two examples at the grinder for spark identification to be used as a laboratory test.

STANDARD STEEL SHAPES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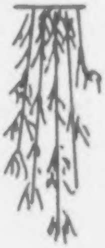
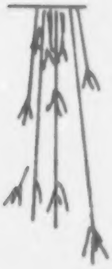
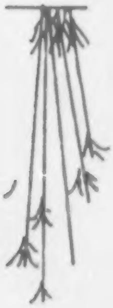
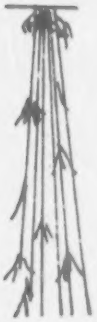
STANDARD STEEL SHAPES

1.	Sheets	3/16" thickness (gauge)
2.	Plates	Over 3/16" thickness
3.	Flat Bars	1/8" - 3" thickness 1/2" - 12" width
4.	Rounds	3/16" to 10"
5.	Half-Rounds	3/8" to 3"
6.	Ovals	1/2" x 1/4" to 1-1/2" x 5/8"
7.	Half-Ovals	3/8" x 3/32" to 3" x 3/4"
8.	Tubes	Wall 1/4" to 3" ; O.D. 2-9/16" to 12"; I.D. 2-1/6" to 11.3"
9.	Squares	1/4" to 6"
10.	Hexagons	3/8" to 3"
11.	I-Beams	H. 3" to 24"; W. 2.3" to 7.9"
12.	Joists	H. 6" to 12"; W. 1.8" to 3"
13.	H-Sections	H. 4" to 36.7"; W. 4" to 16.6"
14.	Channels	H. 1/2" to 18"; W. 1/4" to 4"
15.	Angles	H. 1/2" to 8"; W. 1/2" to 8"
16.	Tees	H. 3/4" to 6.5"; W. 3/4" to 6.5"
17.	Zees	H. 1-3/4" to 6-1/8"; W. 1-1/4" to 3-5/8"

V-90T

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
White and Gray Cast Iron		Top-Red Bottom-Straw Yellow 20" to 25"
Malleable Iron		Straw Yellow About 30"
Wrought Iron		Top-Straw Yellow Bottom-White About 65"
Mild Steel		White About 70"

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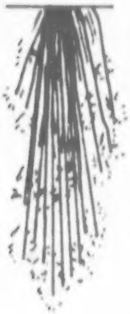
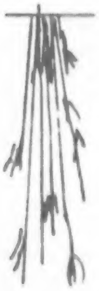
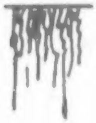
SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
Tool Steel		White About 55"
Alloy Steel		Top-Straw Yellow Bottom-White Length Varies
Nickel		Orange About 10"

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LESSON 14: CUTTING AND FILING METAL

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Name cutting tools and types of files.
2. Demonstrate the proper care and use of the Hack Saw.
3. Demonstrate the proper use of different cold chisels.
4. Demonstrate the proper care and use of files.

MOTIVATION:

To prove time and effort develops proper skills. Quickly draw a circle and determine quality of the circle. Take time to measure distance from several angles to the circumference of the circle, then draw circle. Point out that most people can use hand tools but to use them properly require care and practice.

REFERENCE:

Transparency masters: "Cutting Cold Metal with Hack Saw"
"Use of Cold Chisel"
"Use of Cold Chisel and Bolt Cutter"
"Selecting Files"
"Selecting and Using Files"
"Filing Practices"

OUTLINE:

A. Cutting Tools and Files:

1. Hacksaw
    a. All-hard blades have whole blade tempered.
    b. Flexible blade, has only the teeth tempered.
    c. High speed blade, made to cut faster and longer.
2. Cold chisel
    a. Cope,used to cut out rectangular grooves or channels.
    b. Round nose, oil grooves or channel can be made - makes an oval groove.

   c. Diamond point, used to cut triangle grooves or for making square corners in grooves.
   d. Standard flat, used to cut sheet metal, bolts, nuts, rivets and rods.

3. Bolt cutters:

   a. Cuts from about 3/16 to 3/4 inch thick.
   b. Bolt or rod cutting capacity stamped on the handle should be observed.

4. Metal shears or metal snips used to cut 20 gauge sheet metal or less.

5. Files: (see transparencies)

   a. Mill
   b. Flat
   c. Round
   d. Half-round
   e. Tapered

B. Proper Care and Use of the Hack Saw: (transparency)

1. Use course blade on mild steel or cast iron over 1/8" thick (18 teeth per inch).

2. Use medium blade on hard steel, pipe, and sheet metal (24 teeth per inch).

3. Use fine blade on thin sheet metal and tubing (32 teeth per inch).

4. To insert blade:

   a. Place in frame with teeth pointing away from handle.
   b. Tighten blade in handle.
   c. Retighten blade after it has been used for a short time.

5. There should be two or more teeth on the metal at all times.

6. A file notch makes it easier to start the hack saw.

C. Proper Care and Use of Cold Chisels:

1. Mark metal with an awl, soapstone, scriber, or chalk.

2. Metals 1/8" thick or less can be cut with a flat chisel at a 60 degree angle. The cutting line should be just above the vise jaws.

3. Drive the chisel with a machinist's hammer. Hold chisel firmly in hand while it is hit with the hammer.

4. Dress the head of the chisel by grinding. See Agribusiness I on Care and Sharpening of Tools.

D. Proper Care and Use of Files:

1. Clamp metal slightly above the jaws of the vice to eliminate vibration.

2. Select the proper file to cut the stock.

3. Best position is usually to stand at one side of metal or stock. Stand facing stock so pressure can be applied on the forward stroke.

4. For flat surface filing the metal should be filed by holding the file at a 90 degree angle to the side of the stock.

5. Make a slow full-length stroke by placing the file point on the stock and push it forward, lift it on the back stroke.

6. Long surfaces can be kept flat if the filing is done diagonally on the stock. Check the work with a square.

7. A fine finish is made by drawfiling.

   a. Use a mill file.
   b. Each end of file is grasped and file is placed on metal nearest the body.
   c. Steady pressure is applied while file is pushed forward.
   d. Hold file flat while slow strokes are being made on the stock.

8. Testing metal for hardness:

   a. Extremely hard metal - file will slide over the metal leaving file dull and shiny.
   b. Hard metal - file barely cuts, but dulled if extreme pressure is applied.
   c. Medium hard metal - it is filed.
   d. Soft metal - file teeth become clogged with metal particles.
   e. Cast iron - outer surface is hard so use old file to cut through it before filing with a newer file.

9. Cleaning and care of file:

   a. Rub file with chalk before filing.
   b. Brush with a file card.
   c. Store in racks away from metals, paint and oil.

TEACHING LEARNING ACTIVITES:

1. Display different metal cutting tools and files and allow time for students to identify them.

2. Show and discuss the transparency, "Cutting Cold Metal With Hack Saw."

3. Demonstrate how the blade should be placed and discuss the methods of cutting and describe the different blades that can be used.

4. Show "Use of Cold Chisel." Discuss the different purposes for different types of cold chisels. Point out the parts of the cold chisel.

5. Demonstrate the use of the cold chisel.

6. Display bolt cutters for the class and discuss the importance of using them only on material that they are designed to cut.

7. Display different types of files and show the three transparencies on files. Point out the different teeth arrangements and types of files. Demonstrate the care and use of files.

8. Allow each student to use the cutting tools in the shop on scrap metal.

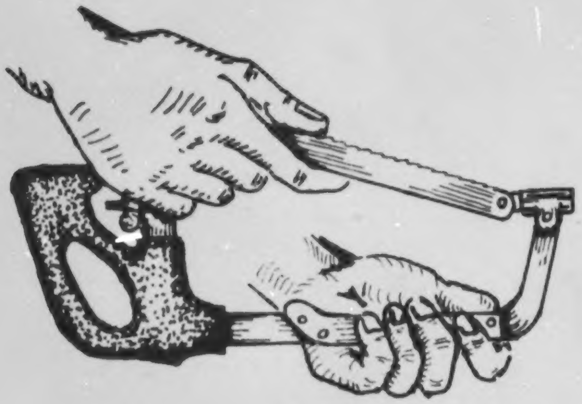
SUGGESTED EVALUATION:

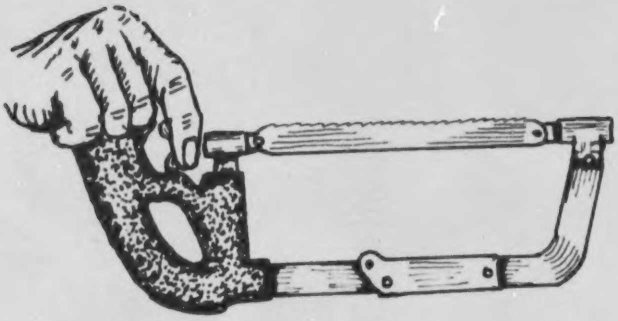
1. Give a quiz on tool identification and ask questions relating to use and care of tools.

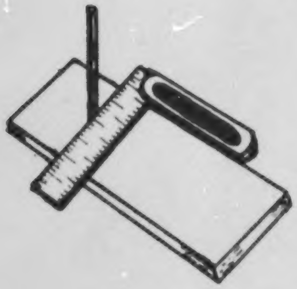
2. Evaluate students' shop activity.

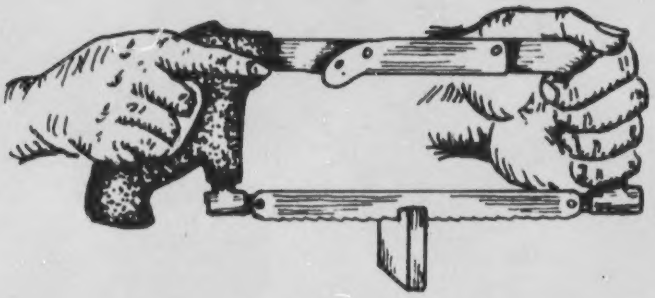
V-96T

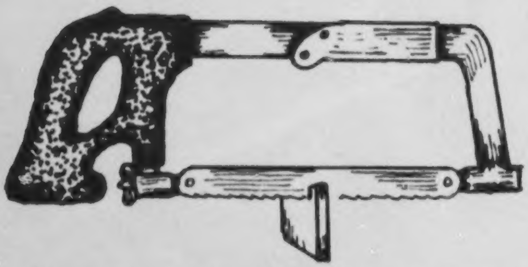
CUTTING COLD METAL WITH HACK SAW

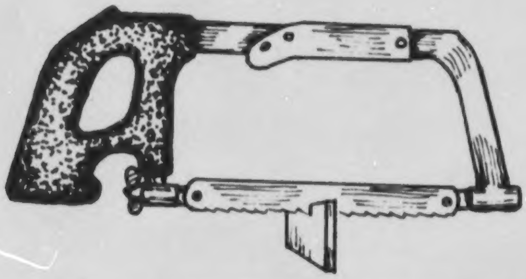

Inserting Blade
Teeth Forward


Tighten Blade
Firmly


Marking Stock


Using Both Hands


Use Pressure Forward Stroke


No Pressure On Back Stroke

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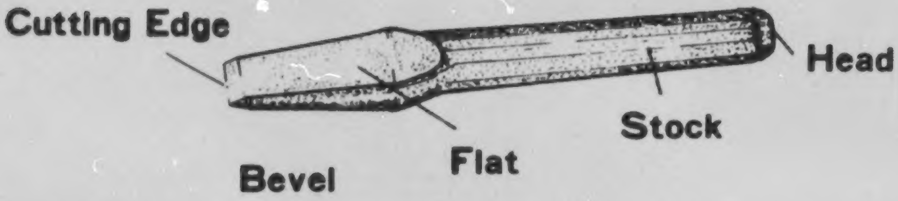
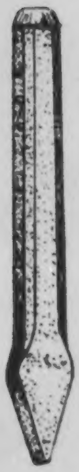
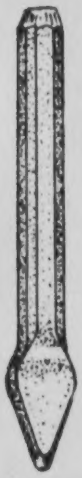
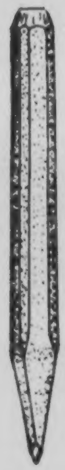
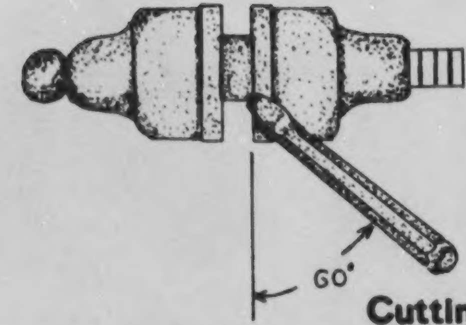
USE OF COLD CHISEL


Cutting Edge
Head
Stock
Flat
Bevel

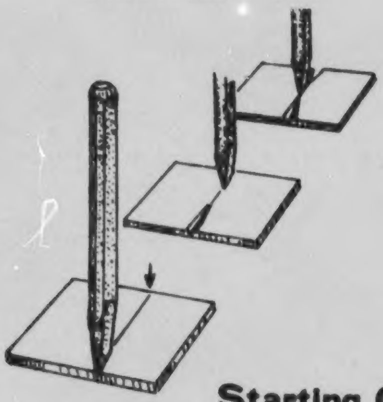

Cape


Round Nose


Diamond Point



Cutting Angle


Starting Cut

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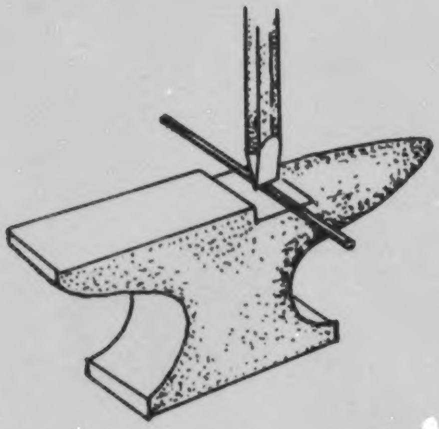
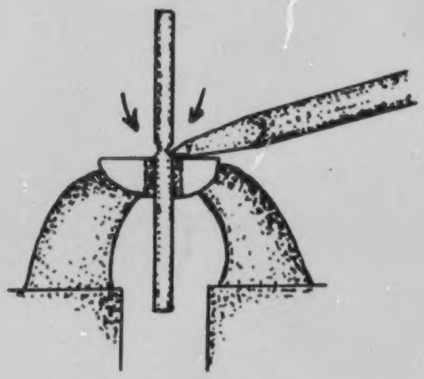
V-98T

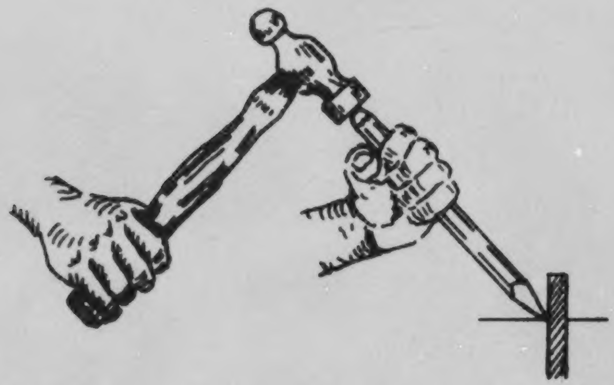
USE OF COLD CHISEL AND BOLT CUTTER



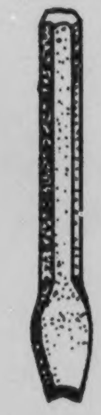
Cut Metal on Anvil Ledge



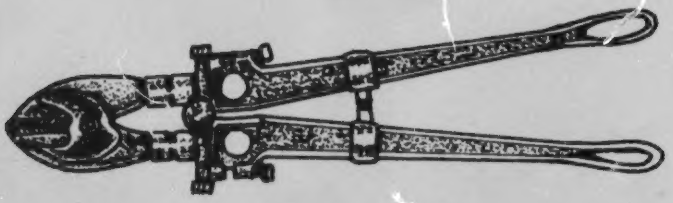
Cut Two Sides of
Rod Before Breaking



Use of Ball Pein Hammer with Chisel



Slitting Chisel



Bolt Cutter

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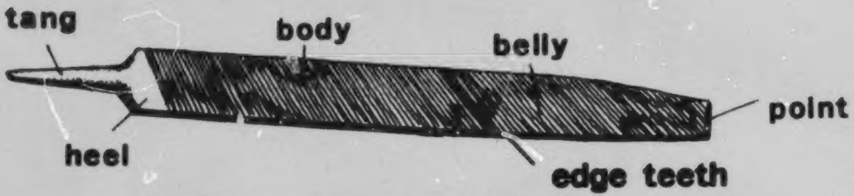
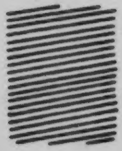
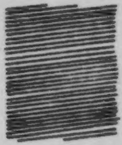
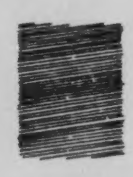
SELECTING FILES


tang
body
belly
point
heel
edge teeth

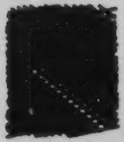
SINGLE CUT TEETH

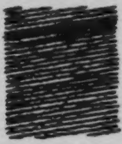

bastard cut

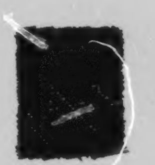

second cut


smooth cut

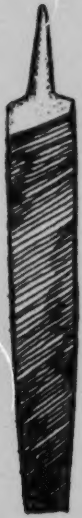
DOUBLE-CUT TEETH

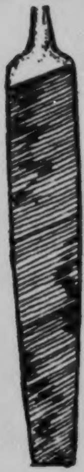

bastard cut

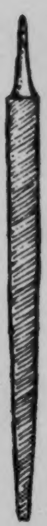

second cut


smooth cut

TYPES OF FILES


mill


flat


square

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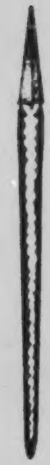
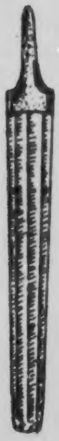
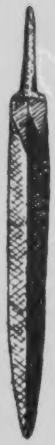
SELECTING AND USING FILES



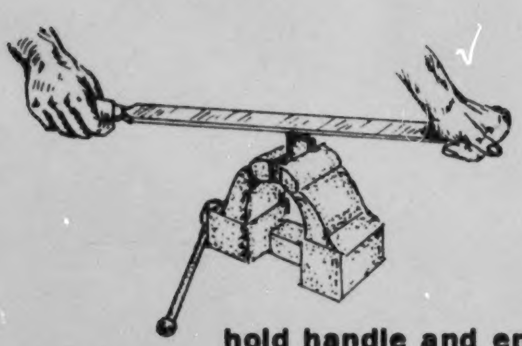
round



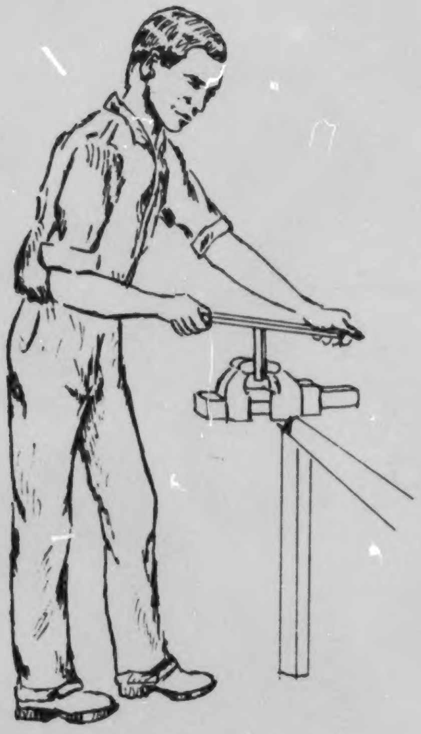
half-round



tapered



hold handle and end firmly-heavy work



position for filing

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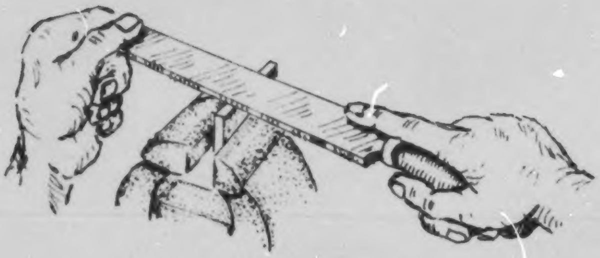
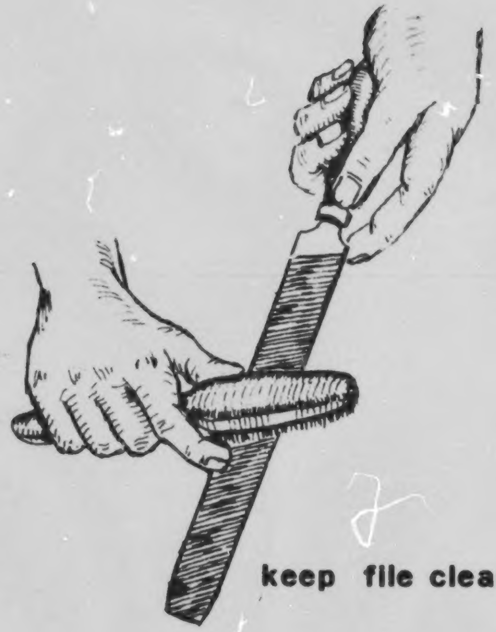
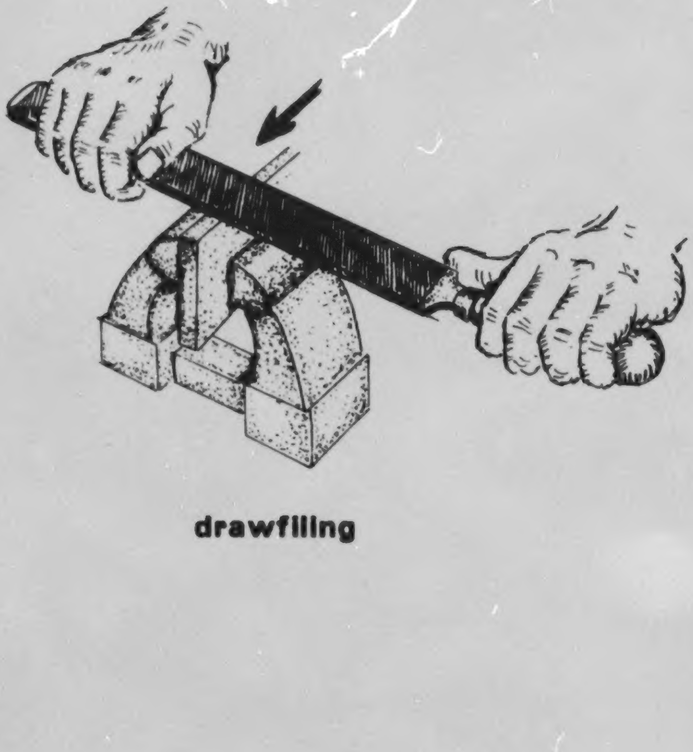
FILING PRACTICES



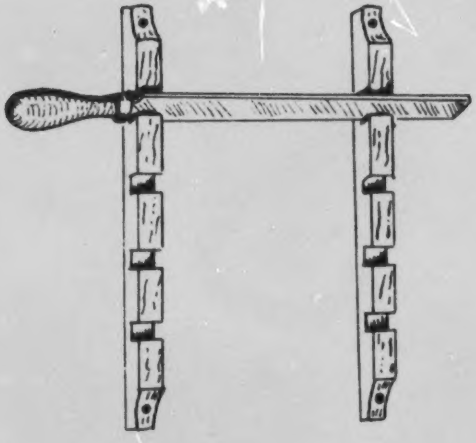
hold handle and end
firmly-light work



keep file clean



drawfiling



proper storage for files

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LESSON 15: DRILLING METAL

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Identify types of drills used to drill metal.
2. Identify types of drill bits and their use.
3. Identify different sizes of a twist drill.
4. Drill holes by using different types of bits and drills.

MOTIVATION:

Lay a piece of scrap metal on the table of a drill press. Fasten in a wood bit. Ask students if you have forgotten anything before you begin. If no answer ask them to tell you what is wrong with this procedure. The wood bit is wrong, the metal should be clamped into position, goggles should be worn, and cutting oil should be available.

REFERENCES:

Transparencies: "Twist Drill Shanks and Parts"
"Drilling a Hole in Cold Metal"

OUTLINE:

A. Types of Drills

1. Portable Electric Drill - Cold metal that is less than 1/2 inch thick can usually be drilled with ease by using a portable electric drill. The portable drill used for most cold metal work has a chuck that will accept a 1/2 inch or smaller straight shank twist drill. This type of drill can be mounted in a drill stand for the purpose of heavier and more accurate drilling.

2. Hand Drill - The hand drill is usually used for drilling holes 1/4 inch or less. This drill is used for light metal work. Holes for small screws, bolts, and rivets can be drilled with this tool.

3. Breast Drill - The breast drill is used to make holes in cold metal up to about 1/2 inch; that is, if the metal is

soft and the twist drills are sharp. This drill can be used for about the same purpose as the portable electric drill.

4. Post Drill - Post drills are used to drill large holes in metal. Due to the slow method of turning it by hand, the post drill will cut harder metal than other types of drills.

5. The drill press is a very important power tool for drilling thick or hard metal. Much more pressure can be applied by using a drill press than by using hand drills; therefore, it is used more than any other drilling tool. One of the limitations in using the drill press is its limited mobility. It cannot be moved and used in different places as can the hand drill.

B. Type of Drill Bits

1. Flat - This bit has no flute. It is flat on both sides with two cutting edges. The bit will cut soft to medium hard metal.

2. Straight Fluted - This bit or drill has two straight flutes extending the length of the body. It will cut copper, brass, and other soft metal.

3. Twist - This drill is one of the most commonly used in metal work. The two-lip twist drill will cut different thicknesses of solid metal. Three- and four lip twist drills are made to enlarge holes.

    a. Types of shanks
        (1) Straight
        (2) Square or Bit-Brace
        (3) Bit stock
        (4) Taper or Morse
        (5) Blacksmith's
        (6) Ratchet
    b. Parts of a twist drill:
        (1) Shank - Top part held by chuck
        (2) Body - Part where grooves are cut
        (3) Flute - Grooves that run along the body
        (4) Tang - Flattened end of shank
        (5) Cutting lip - The cutting edge
        (6) Web - Metal in center with flutes on each side
        (7) Margin - Outer part of cutting edge
        (8) Point - Cone shaped cutting end

C. Identifying the Size of a Twist Drill

1. Fractional - This drill measurement is most commonly used in agriculture mechanical shops. Diameter of drill bits are determined by fractions of an inch. For example,

they range in size from 1/64 of an inch and usually do not exceed one inch in diameter.

2. Alphabetical - The sizes of drills are also determined by letters A through Z. The letters actually are given in size in fractions of an inch which are measured by thousandths (.234" to .413").

3. Numerical - Alphabetical and numerical drills are often used by machinists. Drills #80 to #1 range in sizes from .0135" to .228". The #1 drill (.228") is a few thousandths smaller than 1/4 inch, and the #80 drill is a fraction larger than a human hair.

D. Steps to Observe When Drilling Cold Metal

1. Use a scribe or scratch awl and mark a cross (+) on the metal at the center of the hole where the metal is to be drilled.

2. Dent the metal where the two lines cross by using a center punch. Check the dent to see if it is centered where the two lines cross, then hit the punch with a heavy blow to form a large dent for the-drill.

3. Select the proper size- and type of twist drill. It may be necessary to use a twist drill gauge to determine the exact size needed. The drill should be placed firmly in the drill chuck either by hand for a keyless chuck, or by the use of a key for a keyed chuck.

4. The work or stock to be drilled should be held firmly in a vise, held by a monkey wrench, or held by clamps.

5. Lubricate both the drill and hole while drilling. The type of lubricant to use depends upon the type of metal being drilled.

6. Apply steady pressure to the drill so that a smooth even cut is made as the bit passes through the metal. Hold back on the pressure as the point begins to pierce the underside of the stock.

7. When using any type of hand drill the first precaution to observe is to hold the drill straight. Any leaning or side pressure may break the drill.

8. To drill holes more easily, use a two drill method. Select a drill the size of the web of the large drill and make the first hole (pilot hole), the follow with the large drill.

9. Usually, the larger drill bit should turn slower than the smaller drill bit. Cutting lips can be dulled or burned if too much speed is used on certain hard metals.

10. Remove chips and shavings with a brush, blunt tool, or air when drilling a hole. If the flutes become clogged with either chips or shavings, the drill body may be twisted and broken. Steel produces shavings and cast iron produces chips during the drilling process.

11. As the drill point passes through the metal, pressure must be lessened on the handle or handles.

TEACHING LEARNING ACTIVITIES:

1. Discuss with class the different types of drills that are available describing their use and the safety procedures to use while operating them.

2. Display different drill bits and discuss their use with the class.

3. Show the transparency "Twist Drill Shanks and Parts" and discuss the purposes for the different shanks. (Used for different chuk adjustments in different drills.)

4. Explain and discuss how twist drill bits are classified according to size.

5. Show the transparency "Drilling a Hole in Cold Metal." Refer to oultine on steps in drilling a hole.

6. Demonstrate the procedure for drilling a hole. Emphasize the safety procedure while performing the drilling procedure.

7. Allow students to practice drilling.

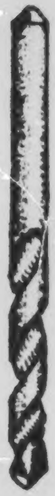
SUGGESTED EVALUATION:

1. Combine the shop activities with lesson 9 and evaluate each student.

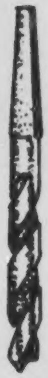
2. Quiz students on types of drilling equipment and safety practices.

V-106T

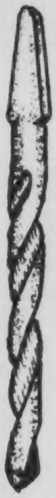
TWIST DRILL SHANKS AND PARTS



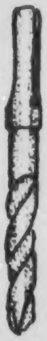
straight shank



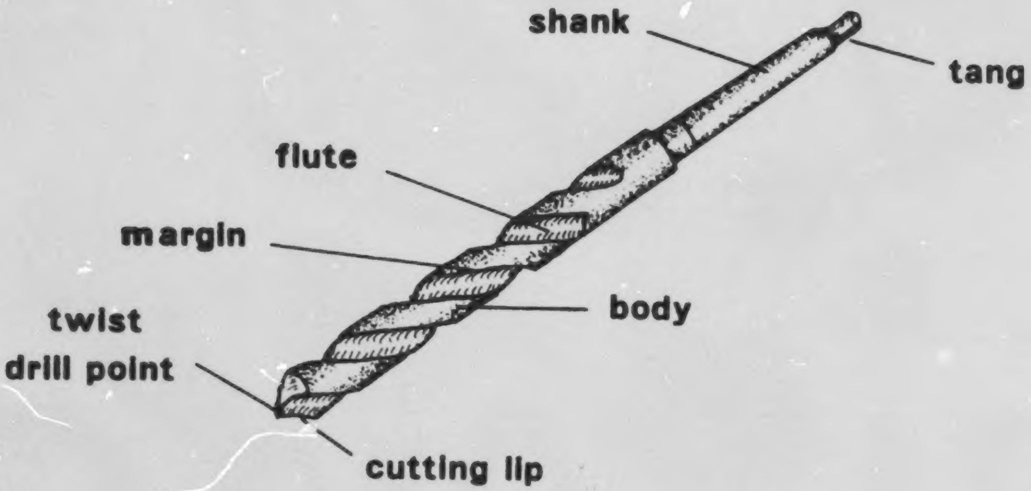
taller or morse shank



square shank



blacksmith's shank


shank
tang
flute
margin
body
twist
drill point
cutting lip

TWIST DRILL PARTS

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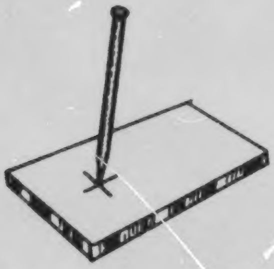
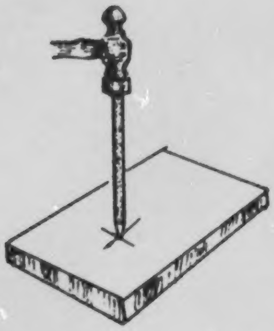
V-107T

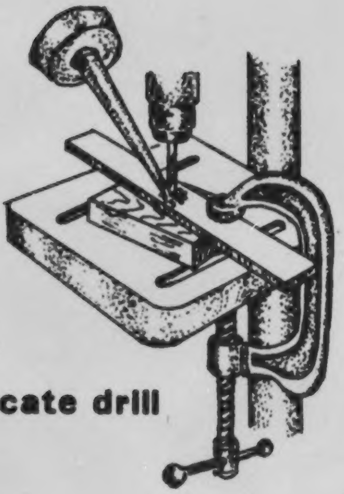
DRILLING A HOLE IN COLD METAL



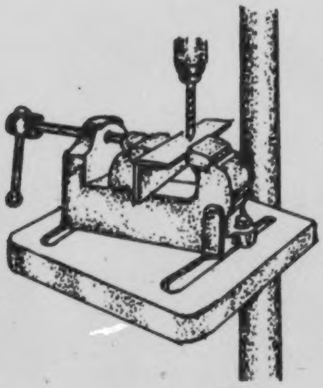
center by making a cross



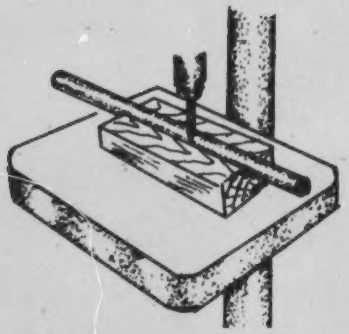
dent with center punch



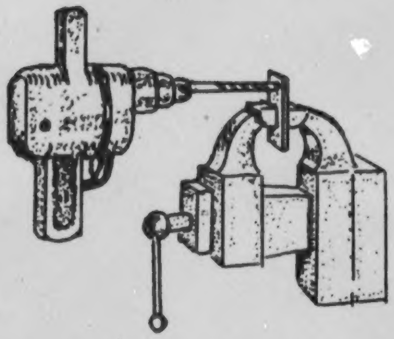
lubricate drill



vise for drill press



drill round metal
with V-block



hold metal in machinist's
vise when hand drilling

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LESSON 16: SHAPING COLD METAL

2

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Demonstrate safe procedure when working with cold metal.
2. Identify tools used for bending and shaping metals from pictures and examples.
3. List types of iron used to make objects or projects.
4. Demonstrate the procedure used in making a bend.
5. Make selected shapes by bending the metal.

MOTIVATION:

Get some prices of gate hinges and hardware, compare that with the price for flat and bar iron. Ask the class if they want to save some money. Tell them they will learn how to make the eye part of a strap hinge.

REFERENCES:

Transparency Masters: "Bending and Twisting Metal"
"Bending and Shaping Metal"

OUTLINE:

A. Safety:

   1. Check vise to be certain of tight hold on metal to be shaped.
   2. Avoid pinch points when bending metal.
   3. Use a heavy enough hammer to shape the metal.
   4. Do not use a sledge hammer against a vise and it should not be used on an anvil if sledge hammer weight exceeds the weight of a heavy machinist's hammer.
   5. Use heavy duty monkey wrenches.
   6. Always wear safety goggles.
   7. Check immediate area for others before swinging the hammer.

B. Purposes for Shaping Cold Metal:

1. Ornamental iron work
2. Braces for farm equipment
3. Gate and door hardware
4. Shelf framing and supports
5. Hardware for truck and trailer beds

C. Tools Used to Shape Cold Metal:

1. Blacksmith's vise
2. Machinist's vise
3. Anvil
4. Bending jigs
5. Measuring tools
6. Piece of pipe and rod
7. Sledge hammer
8. Blacksmith's hammer
9. Machinist's hammer
10. Monkey wrench
11. Marking tools
12. Ball peen hammer

D. Types of Iron:

1. Flat iron
   - a. Black mild steel
   - b. Cannot be hardened due to low carbon content
   - c. Sometimes called blacksmith's steel, soft iron, and machine steel
2. Round iron and square rod iron
   - a. Commonly known as rod steel or rod iron
   - b. Uses are similar to flat iron

3. Wrought iron

    a. Tough malleable steel
    b. Found as flat, round, and bar wrought iron

4. Angle iron

    a. Molded in a shop to give it strength
    b. Much of it is made of mild steel some made of wrought iron

E. How Metal is Bent and Twisted:

1. Measure and mark the place for bending or shaping.

2. The metal is placed between metal fillers in the jaws of a heavy duty vise. The fillers are to protect the metal from being marred, a practice that is not always necessary.

3. Use a ball peen or machinists' hammer to bend the metal to the desired angle. Metal should be bent from the top of the vise.

4. Check the degree of angle with a try square, T-bevel, or a template during the operation.

F. Making an Eye:

1. Select a piece of round stock (pipe or rod) the same diameter as the eye desired.

2. Place the flat metal and round stock in the vise. The flat metal should extend at least halfway the distance of the diameter of the round stock.

3. Bend the metal over the round stock which is level with the vise jaws by aid of a hammer.

4. Extend the bent end of the flat stock to the bottom and center of the round stock and repeat the bending step.

5. Place the end of the U-shaped stock at the top edge of one vise jaw and repeat the bending step for the third time. Each time the flat stock is placed in the vise, the straight part should be parallel to the vise jaws.

6. If the straight part of the flat stock is bent, the stock is placed parallel to the inside of the vise jaw before bending. A hammer must be used in the first three bending steps.

G. The Procedure for Twisting Metal is Given Below:

1. It is necessary to select metal stock longer than the exact measurement needed because twisting shortens the stock. Cut the stock to the proper length after it is twisted.
2. Clamp the bar or flat iron in the vise between two metal fillers. The two ends that are free of the twist should be held by the vise and wrench at the same distance from where the twisting will begin.
3. Use a monkey wrench to twist the flat or bar metal the desired number of turns. Proper twisting will give the metal strength, whereas excessive twisting will cause the metal stock to be weaker.
4. When twisting long metal stocks, a close fitting piece of pipe slipped over the stock will prevent it from bending. The pipe should be the length of the twist.

H. Using a Drawing or Pattern:

1. A piece of string or copper wire used to follow a pattern through the curves to determine length of metal needed.
2. The ends should be shaped and the end bend should be started on an anvil.
3. The jig or bending fork placed securely in a vise.
4. If the jig has adjustable posts, they should be adjusted to the thickness of the stock.
5. Use of hands, pipe, and hammer to form the curves and angles.
6. The object should be checked by placing it over the drawing. If the bend is too short, a vise may be used to straighten it.

TEACHING LEARNING ACTIVITIES:

1. Ask students what safety features need to be considered when shaping cold metal. Use the outline for assistance.
2. Display some materials that were made from bending or shaping cold metal. Wrought iron furniture, fences, etc.
3. Discuss with class what materials on the farm or in other types of agribusiness are made by shaping cold metal.
4. Display the tools to be used to shape cold metal. Discuss the use of each tool.

5. Have students bring in samples of iron to be shaped or locate different types of iron to show the class. Discuss the uses of each type.

6. Show both of the transparencies and discuss how metal is shaped.

7. Demonstrate to the class methods of shaping metal.

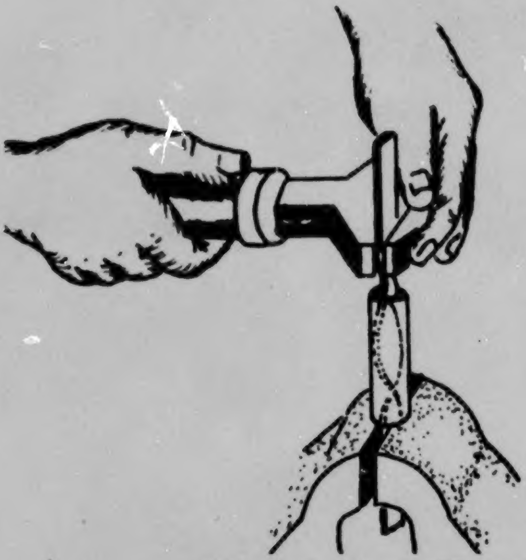
8. Have each class member work on an iron shaping project. Make the strap for a gate hinge by making an eye.

SUGGESTED EVALUATION:

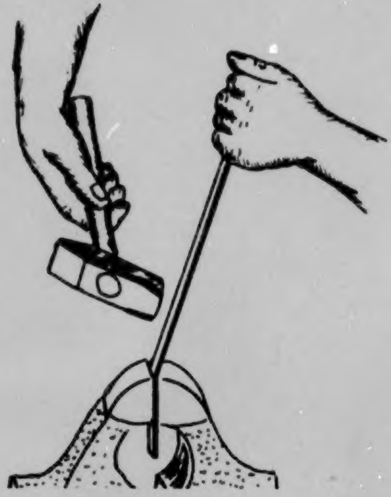
1. Quiz students on safety, types of tools, types of metals, and methods of shaping.

2. Grade the students' activity in the shop.

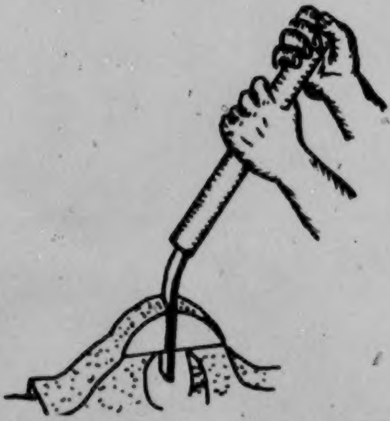
BENDING AND TWISTING METAL



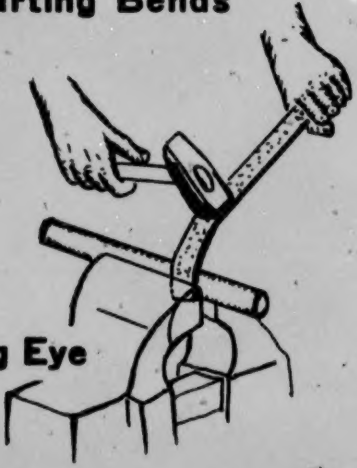
Making Long Twists



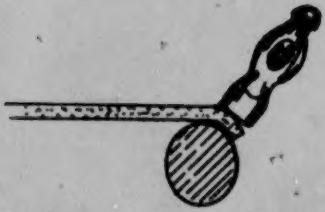
Use of Hammer Starting Bends



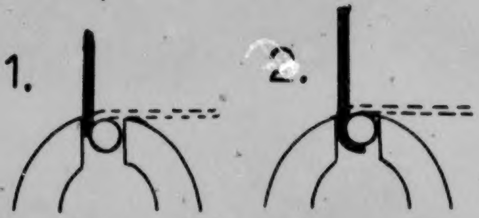
Use of Pipe to Start Bend



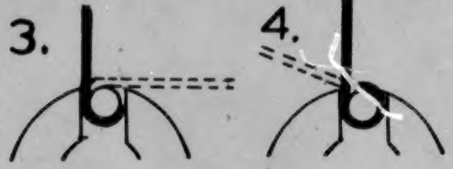
Starting Eye



Starting Eye on Anvil Horn



Four Steps for Making Eye



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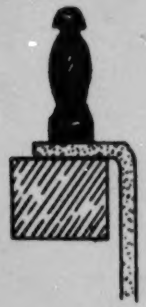
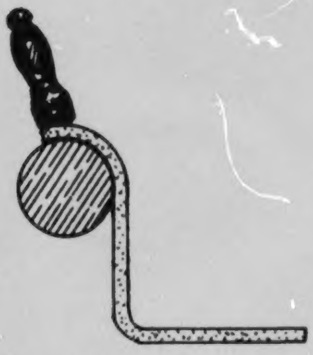
BENDING AND SHAPING METAL

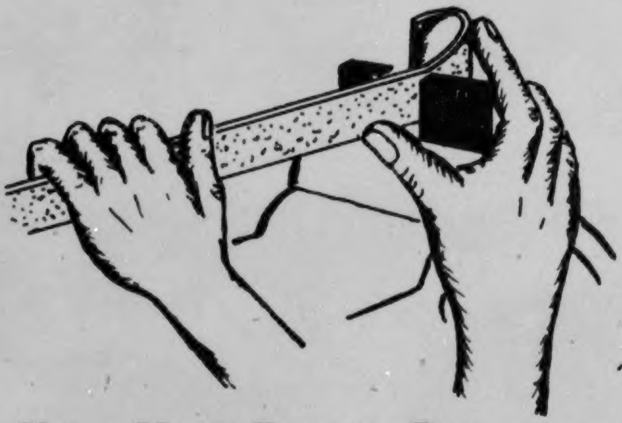
V-114T



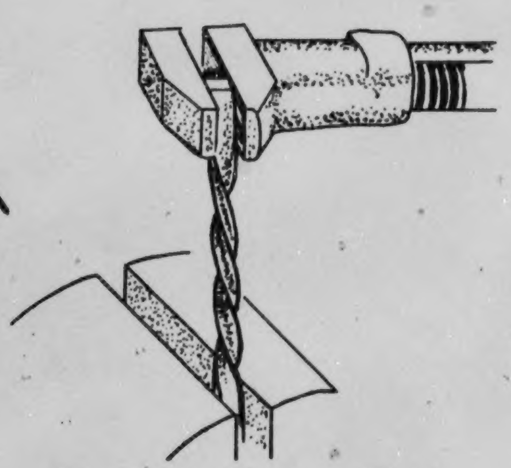
Ninety Degree Bend on Anvil



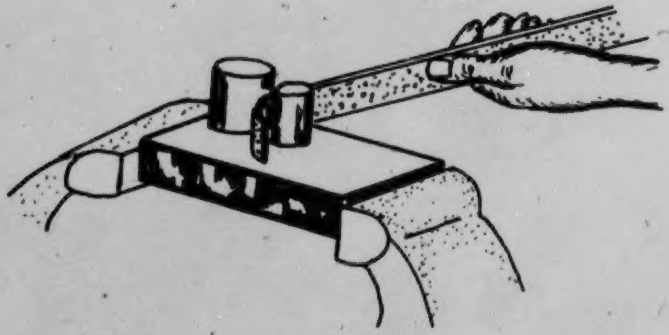
Shaping End on Anvil Horn



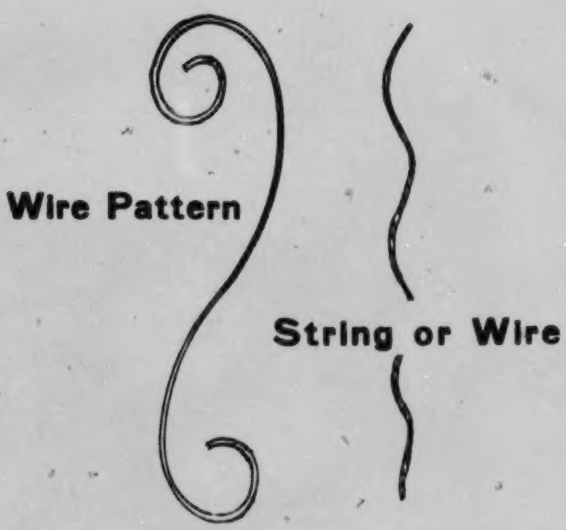
Using Metal Bending Fork



Twisting Square Rod



Using Jig to Bend Metal



Laying out Designs

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LESSON 17: THREADING

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Demonstrate safety while threading a bolt and nut.
2. Identify tools by listing the proper name and type of thread.
3. Thread a bolt and nut.

MOTIVATION:

Allow each student to thread one bolt and nut.

REFERENCES:

Transparency Masters: "Tools for Threading and Tapping"
"Taps and Dies"
"Threading and Tapping"

OUTLINE:

A. Safety and Care of Tools:

   1. Wear safety goggles
   2. Secure materials in a vise before working
   3. Keep area clean of oil and materials
   4. Clean equipment and tools after use
   5. Use a light weight oil when cutting threads
   6. Use a sharp drill bit
   7. Do not let drill bit overheat
   8. Use the right tools for the job

B. Importance of Threading Skills:

1. Can repair bolts and threads that have been damaged in a part on the machinery.
2. Can thread rods to be used as supports on wagons and other agricultural structure.
3. Cutting and reshaping threads is a common task in many shops.

C. Tools Required for Threading:

1. Dies of different sizes - used to cut male threads.
2. Die stock (handle) - holds the die and guide while cutting.
3. Tap - used to cut threads inside a hole or nut.
4. Vise
5. File
6. Oil containers

D. Types of Threads:

1. N.C. Taps and dies for National Coarse threads are used on braces, bolts and adjustment rods in farm machinery.
2. N.F. Taps and dies for National Fine threads are used on tractors, cars and trucks.

E. Kinds of Taps:

1. Taper - to make threads in holes drilled through the metal.
2. Plug - used to follow the taper tap in holes that are not drilled all the way through the metal.
3. Bottoming - is not tapered at the bottom and the threads are the same size from top to bottom. It is used to follow the other two taps in holes that do not pass through the metal.

F. Three Kinds of Dies:

1. Solid die - cannot be adjusted.
2. Round split die - can be expanded or made smaller by an adjustment screw on the side.
3. Two-piece die has two thread cutting jaws.

G. Threading a Bolt:

1. Bevel the edge of the bolt.

2. Place the bolt in a vise to hold it firmly while threads are being cut.

3. Select a die of the proper size and place it over the bolt, guide first, and apply pressure as the turn is made clockwise.

4. After the first complete turn, apply a lubricant and thereafter apply the oil about every third turn. (When threading cast iron, oil should not be used.)

5. The die may be turned the desired length of the thread, except in the case of small diameter die when the die flutes fill with loose metal and begin tearing the threads. The loose metal may be punched out of the flutes or the die may be turned back one-fourth turn each full turn. The backward movement breaks the chips that form on the forward turn.

6. Remove the majority of all chips from the flute before removing the die from the bolt.

7. If the bolt is being cut for a particular nut, try screwing it on a bolt of the same size in diameter and the same type of threads being cut or cut a few threads and try the nut on the bolt.

8. Hardened steel rod should not be threaded with a die. The die must be harder than the metal it is to cut.

H. Tapping a Hole:

1. Select a twist drill for the proper size of hole to be threaded. The size of a drill is usually determined by a chart or by using the second visible thread on a taper tap. A hole that is too large will give incomplete threads. A hole that is too small will cause too much pressure to be put on the tap.

2. Secure the stock or nut being tapped so that it will not move from the tapping position.

3. A downward pressure should be applied on the tap at the same time it is turned in the hole. After the tap begins to take hold of the metal, the pressure is released.

4. Apply a lubricating oil to the tap operation as applied in the die operation.

5. The flutes of a tap can be kept clean in most cases if a one-fourth counter-clockwise turn is made after each full turn.

6. Clean the tap flute before removing it from the hole.

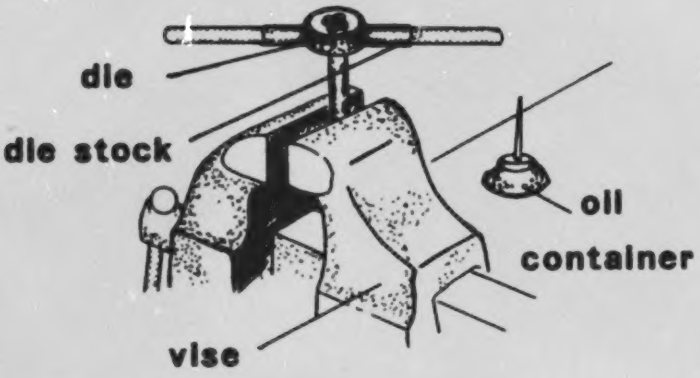
TEACHING LEARNING ACTIVITIES:

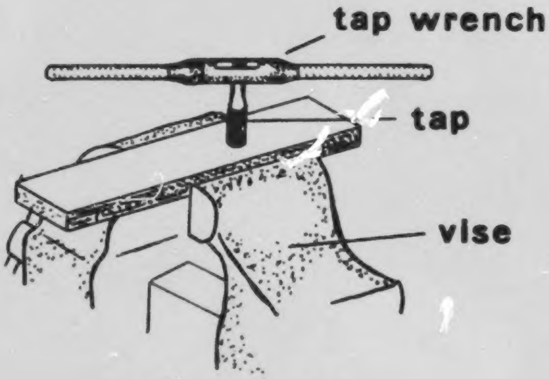
1. Display and discuss the types and uses of the threading tools.
2. Show the transparencies on tools and discuss how they are to be used.
3. Show the transparency on threading and tapping, Point out safety features that should be considered when working.
4. Demonstrate how to use the die or tap to cut threads.
5. Allow each student to use the threading tools.

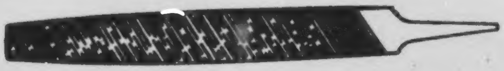
SUGGESTED EVALUATION:

1. Evaluate each student's shop activities.
2. Quiz each student on tools and procedures.
3. Shop activities and quizzes could be combined on lessons 11 and 12.

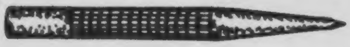
TOOLS FOR THREADING AND TAPPING


die
die stock
oil
container
vise

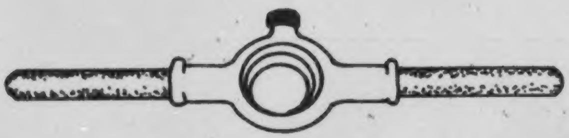

tap wrench
tap
vise



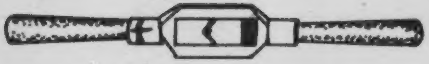
flat file



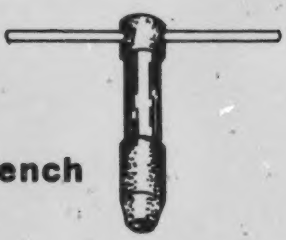
punch



die stock



tap wrench



T-tap wrench

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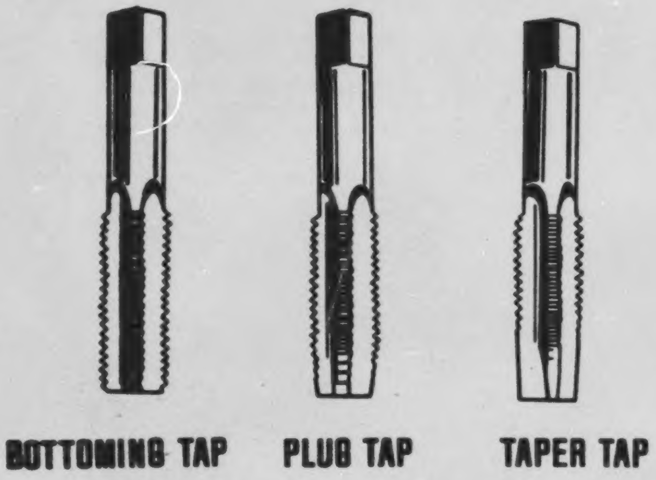
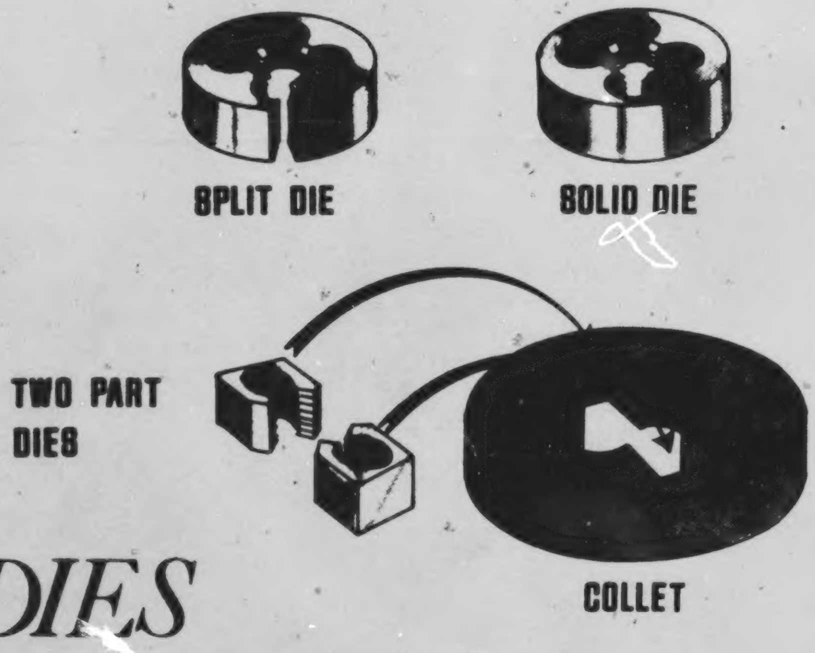
TAPS


BOTTOMING TAP
PLUG TAP
TAPER TAP

DIES


SPLIT DIE
SOLID DIE
TWO PART DIES
COLLET

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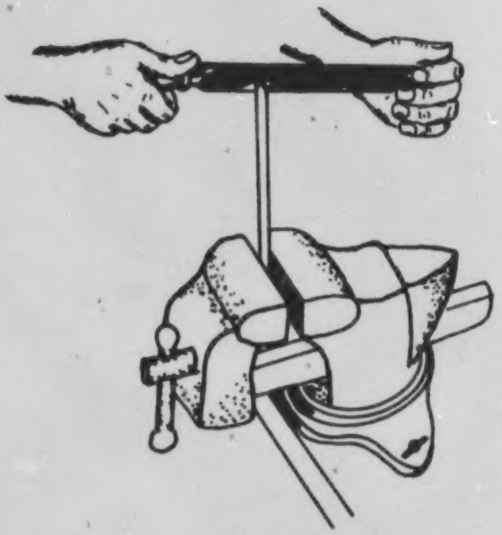
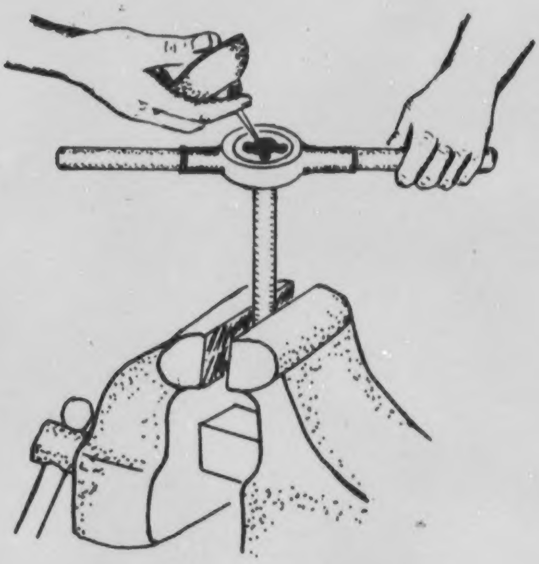
V-121T

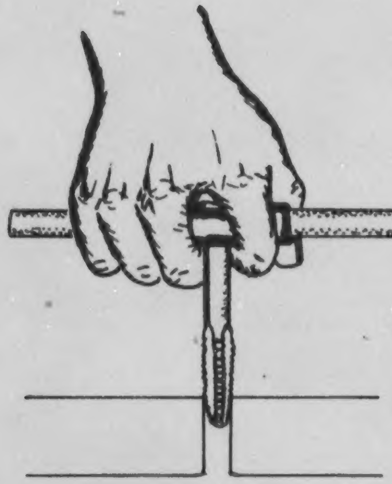
THREADING AND TAPPING



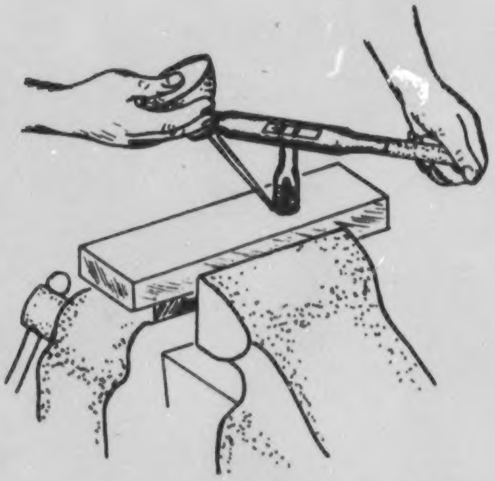
beveling the edge



lubricating the die



tapping a hole
starting tap straight



lubricating the tap

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LESSON 18: PLUMBING TOOL AND PIPE SELECTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Define basic plumbing terms.
2. Identify tools used in plumbing from examples.
3. Describe how pipe size is determined as it relates to copper tubing.
4. List the common sizes of pipe and copper tubing.
5. Select the kinds of pipe for a specified job.

MOTIVATION:

Tell the class that you have been asked to plan a water and waste system for a farm, business, or greenhouse. Show the class some samples of pipe. Ask the students which pipe should be used as the soil pipe and what type of pipe should be used as the lateral pipe. Tell the class that they should first know a little about plumbing terminology and the uses of the different pipes before work begins.

TRANSPARENCY MASTERS: "Plumbing Tools" 1, 2, 3,"

OUTLINE:

A. Plumbing Terms:

   1. Plumbing-- pipe and pipe attachments used to carry water into buildings and to drain away sewage and waste.
   2. Soil pipe--any pipe that receives the discharge of waste water from house fixtures.
   3. Fitting--piece used to join pipe, to provide opening in pipe, and to change the direction of pipe.
   4. Trap--water-sealed bend or chamber in a waste pipe.
   5. House drain--pipe which carries all the sewage from the house.
   6. Stack--soil, waste, or ventilating pipe.
   7. Fixture--appliance connected to the plumbing.
   8. Septic tank--tank which received all the sewage piped into it and allows the process of sewage treatment to take place.

9. Lateral pipe--pipe which drains the liquid from the septic tank to the soil.

B. Plumbing Tools:

1. Pipe vise:

    a. Hinged
    b. Chain
    c. Combination

2. Pipe cutter

3. Hack saw

4. Pipe wrenches

5. Burring reamer - to remove burr made on end of pipe when it is cut.

6. Flare tool - used to form a flare on ends of copper tubing when flare type fittings are used.

7. Stocks and dies - to be discussed in more detail in lesson on threading pipe.

C. Size of Pipe Compared to Copper Tubing Sizes:

1. Pipe size determined by inside diameter.

2. Tubing size determined by outside diameter.

3. Pipe wall generally thicker.

D. Common Sizes of Pipe and Copper Tubing:

1. Pipe:

    a. 1/4"
    b. 1/2"
    c. 3/4"
    d. 1"
    e. 1 1/4"

2. Copper tubing:

    a. 3/8"
    b. 7/16"
    c. 1/2"
    d. 3/16"
    e. 5/8"

E. Types of Pipe:

1. Galvanized pipe - more used for plumbing than any other type.
    - a. Lasts 30-40 years under normal conditions
    - b. Corrodes easily under alkaline and acid conditions
    - c. Will burst if frozen
    - d. Purchased in three weights of standard, extra strong, and double extra strong.
    - e. Extra strong and double extra strong are usually connected by flanges or welded
    - f. Purchased in wide range of sizes 1/8" smallest to 12 inches largest

2. Black steel pipe:
    - a. Same sizes as galvanized pipe
    - b. Corrodes quickly
    - c. Not used on most plumbing jobs
    - d. Most economical pipe to buy
    - e. Used in gas lines where it is protected from the weather and soil

3. Brass and copper tubing:
    - a. More copper used than brass
    - b. Two kinds of copper tubing, type K (heavy duty) and type L (standard)
    - c. Resistant to corrosion
    - d. Life of 40-100 years
    - e. It can freeze several times before it will burst
    - f. Useful in areas where rigid pipes are difficult to lay
    - g. Purchased in twenty-five foot coils, and nine dimension sizes from 1/8" to 1"

4. Plastic pipe:
    - a. Easily laid and doesn't require special tools
    - b. Easily punctured
    - c. Looses strength under prolonged exposure to weather
    - d. Should not be used for hot water
    - e. Most city ordinances prohibits its use in the home
    - f. Available in rigid plastic pipe in 10 foot sections and flexible pipe in 60 foot coils
    - g. Available in four inch sizes
    - h. Perforated type used for septic tank drainage and field drainage .
    - i. Solid type used for house to sewer, downspout drainage and non-pressure uses

5. Cast iron pipe: (not commonly used today)
   a. Used for drains and vents
   b. Ranges in size from two to twelve inches in diameter
   c. Purchased in five foot lengths and in both single and double hubs
   d. Does not corrode and will last indefinitely

TEACHING LEARNING ACTIVITIES:

1. Give a pretest over basic plumbing terms then review the answers in class.

2. Display the basic plumbing tools and different types of pipe.

3. Discuss the tool use, show transparency of tools.

4. Discuss the common pipe sizes and how pipe sizes are measured.

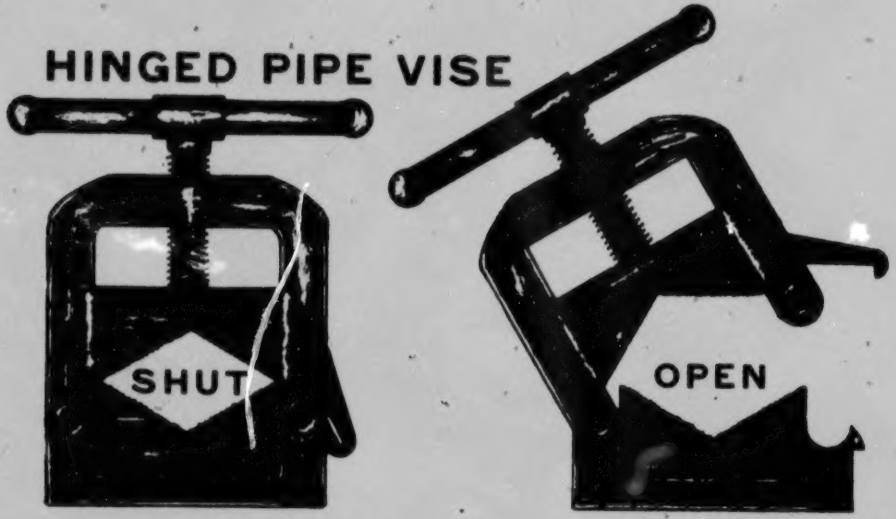
5. Take samples of pipe from display and discuss the qualities and uses of each type.

SUGGESTED EVALUATION:

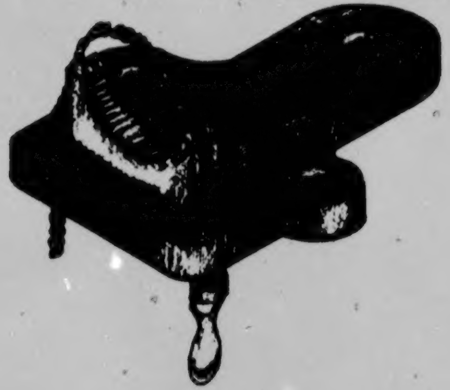
1. Written quiz on lesson material.

PLUMBING TOOLS

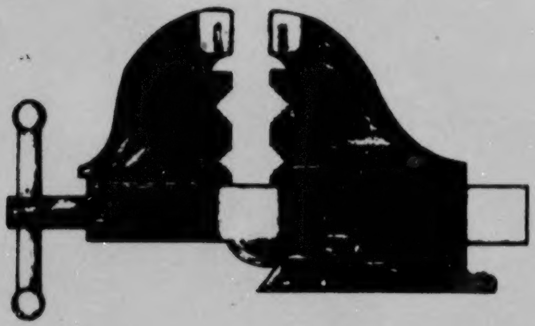
HINGED PIPE VISE



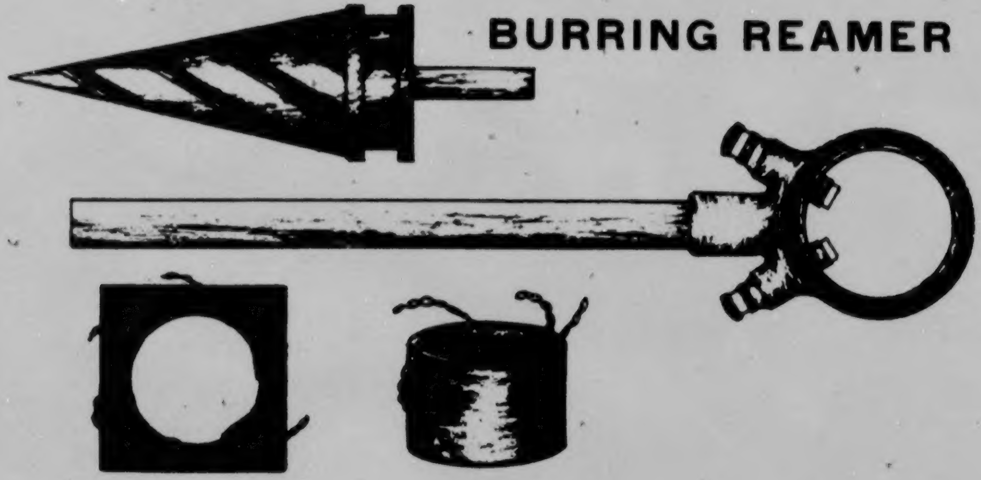
CHAIN PIPE VISE



COMBINATION PIPE VISE



BURRING REAMER



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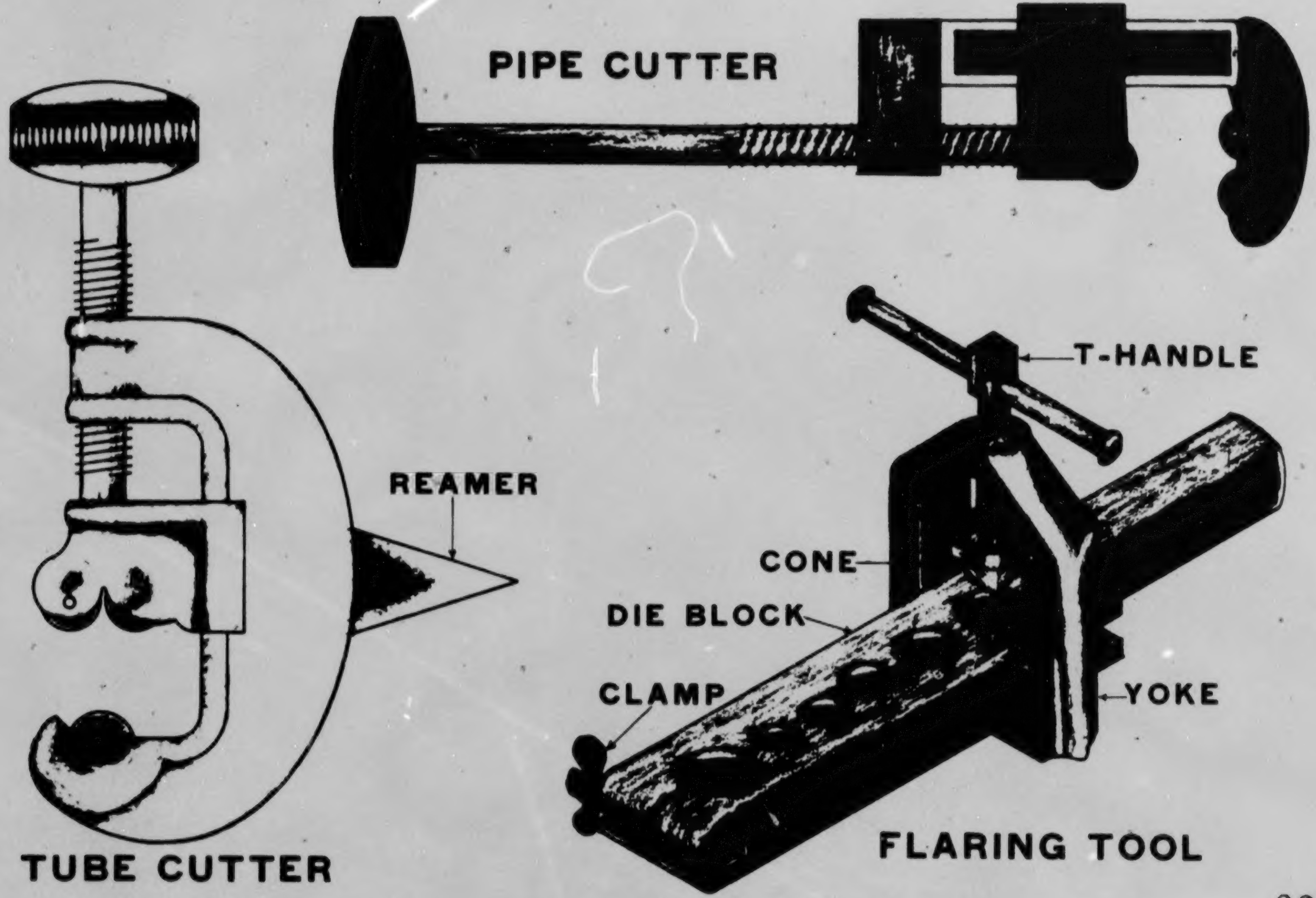
PLUMBING TOOLS


PIPE CUTTER
T-HANDLE
REAMER
CONE
DIE BLOCK
CLAMP
YOKE
TUBE CUTTER
FLARING TOOL

V-127T

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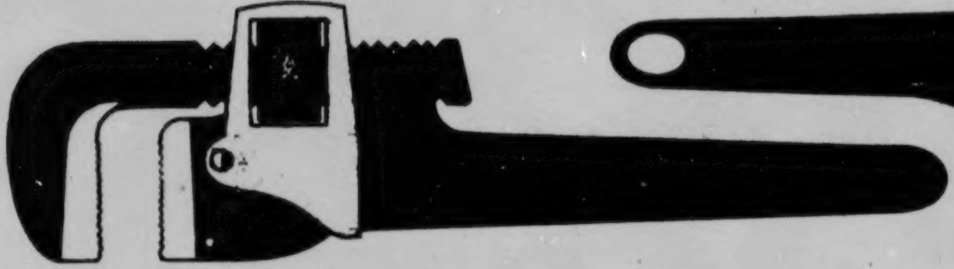
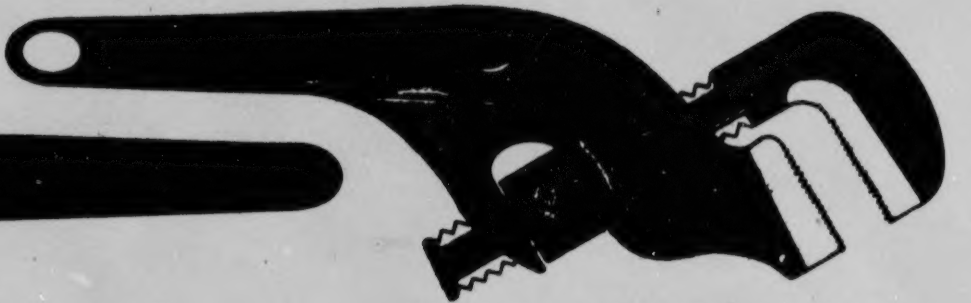
PLUMBING TOOLS

PIPE WRENCHES

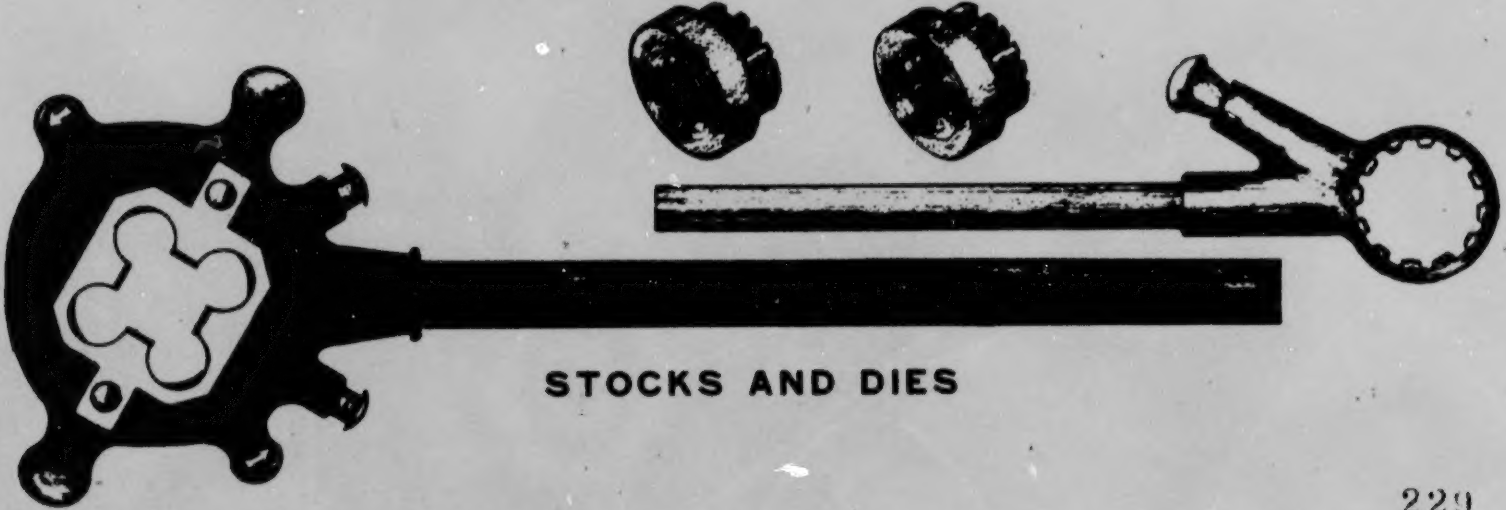


SIZES 6 TO 48 INCHES



SIZES 6 TO 36 INCHES

PIPE THREADERS



STOCKS AND DIES

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LESSON 19: PREPARING PIPE FOR ASSEMBLY

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Demonstrate three methods of measuring pipe.
2. Mark and cut pipe at specified lengths.
3. Thread galvanized and black pipe with the die and stock.
4. Flare copper tubing with a flaring tool.

MOTIVATION:

Allow students to perform shop activities to make water-tight seals.

REFERENCES:

Shopwork on the Farm, McGraw Hill Book Co.

Transparency masters: "Measuring Pipe"

OUTLINE:

A. Measuring Pipe:

   1. The distance between the fittings is measured, and an allowance is made for the thread that screws into the fitting. One-half inch should be allowed for the fitting if one inch pipe is used, and three-fourths of an inch of thread is allowed for pipe 1 1/4 inches to two inches in diameter. This method should not be used when accurate measurements are needed.
   2. A more accurate method for measuring pipe is to measure the distance from the center of one pipe to the center of the other pipe and subtract the diameter of the pipe for each thread.

3. When pipe is larger than 1 1/4 inches in diameter is used, the distance to the center of the pipe is measured, and the fittings are measured from the center of the pipe to the back of the thread of the fitting.

B. Marking Pipe:

The length of the pipe may be measured with a ruler or tape measure, and the pipe should be marked with the edge of a three-cornered file.

C. Cutting Pipe:

1. The opened pipe cutter is slipped over the pipe, and the cutter handle is turned until the wheels are snug against the pipe at the mark.
2. A few drops of oil (cutting oil) are placed on the mark.
3. The pipe cutter is turned around the pipe, and the screw handle is turned one-fourth turn each revolution of the cutter until the pipe is cut off.
4. The reamer is used to remove the burr that is left on the inside of the pipe after it is cut. If the burr is left in the pipe, it will restrict the flow of water.

D. Threading Galvanized and Black Pipe:

1. The pipe is cleaned of dirt, rust, and other materials.
2. The rough edges are removed from the end of the pipe to be threaded.
3. The pipe is secured in a vise.
4. Cutting oil or lard oil is applied to the die.
5. Inward pressure is applied to the die as it is turned on the pipe. After the die becomes engaged on the pipe, the inward pressure should be discontinued.
6. The pipe should be oiled frequently ahead of the die.
7. The threading is continued until one thread is showing outside of the die. More threads should be showing on large pipe. The die should never be turned backwards or back and forth. This will ruin the threads.
8. The die is backed off of the threads carefully. If the die should catch, it should be turned forward again to dislodge the metal chips.

9. The pipe is cleaned of oil and removed from the vise. The die should also be cleaned.

E. Flaring Copper Tubing:

1. A sleeve nut is slipped on the section of copper tubing.
2. The burr, if present, should be removed from the end of the tubing.
3. The tubing is wrapped with cloth or leather (to prevent marring) and placed in a vise.
4. A few drops of oil are applied to the flaring tool.
5. The flaring tool is placed over the end of the tubing, and the tubing is placed flush with the surface of the tool.
6. The flaring tool is screwed into the end of the tubing to make a flare.
7. The flare tool is removed, and the sleeve nut is placed in position. The flared end is now ready to be placed on the fitting.

F. Expansion couplings of copper tubing

1. Place female end threaded coupler on pipe.
2. Place ferrule (expansion washer) on pipe.
3. Attach to threaded male end.
4. As coupler is tightened the ferrule expands and seals the joint.

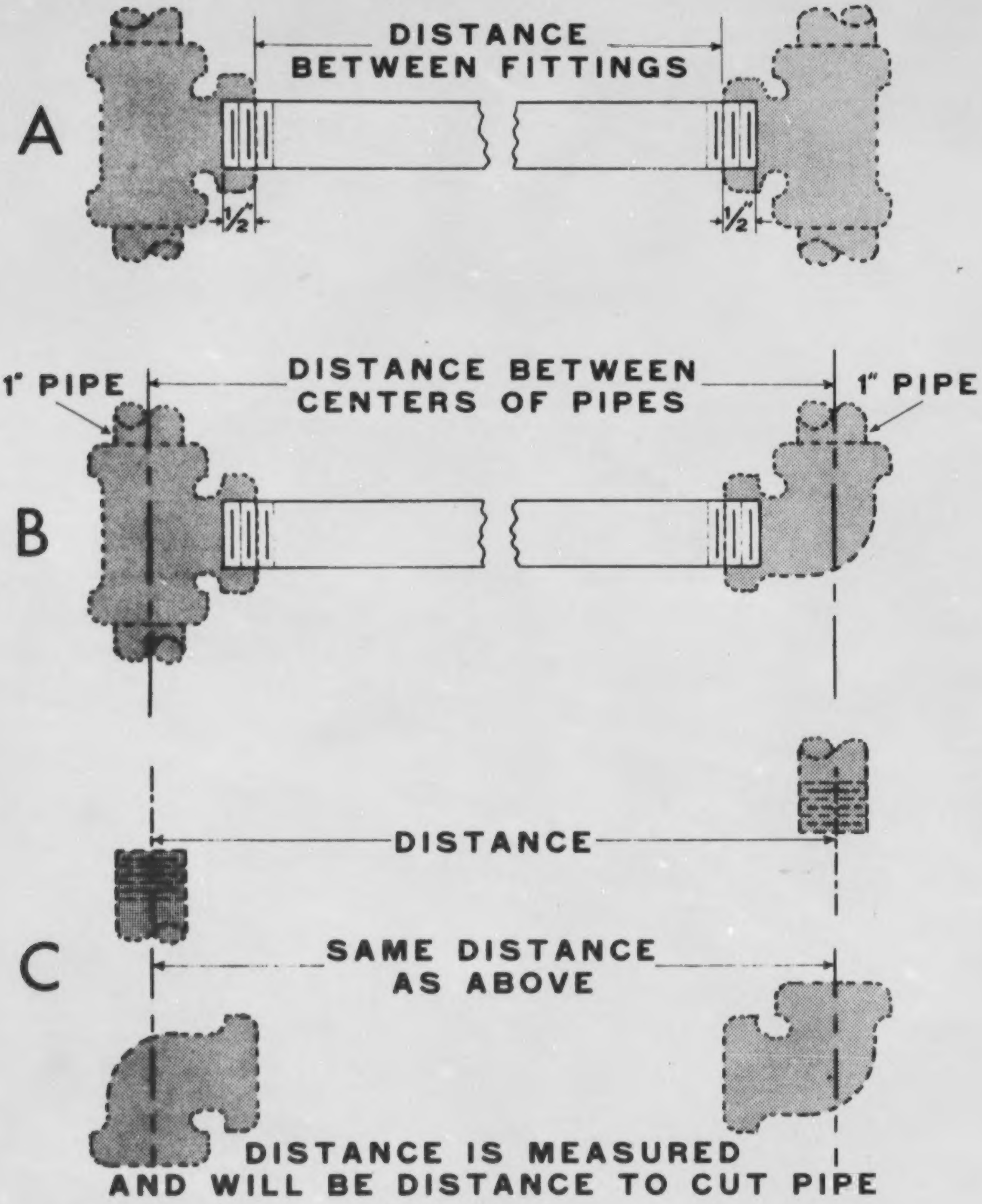
TEACHING LEARNING ACTIVITIES:

1. Use sample pieces of pipe to demonstrate methods used to make measurements.
2. Allow students to figure unknown pipe lengths and fittings.
3. Demonstrate methods of cutting pipe.
4. Demonstrate the use of a pipe reamer and explain the purpose.
5. Use the same pipe that has been cut and reamed to show students how to thread pipe.
6. Have each student complete an exercise in cutting pipe to meet specified lengths.
7. Assign each student to ream the pipe that was cut in the previous exercise.
8. Have each student thread the pipe that had been reamed.
9. Demonstrate the method of cutting, reaming, and flaring copper tubing.
10. Have each student complete a flaring assignment.

SUGGESTED EVALUATION:

1. Grade students on their ability to follow procedures in the assignment sheets and on their workmanship.

MEASURING PIPE


DISTANCE
BETWEEN FITTINGS
A
1/2"
1/2"
1" PIPE
DISTANCE BETWEEN
CENTERS OF PIPES
1" PIPE
B
DISTANCE
C
SAME DISTANCE
AS ABOVE
DISTANCE IS MEASURED
AND WILL BE DISTANCE TO CUT PIPE

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LESSON 20: ASSEMBLING PIPE

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Identify and select pipe fittings for a prescribed connection.
2. Identify types of valves from diagrams and examples.
3. Select the correct valve for a given job.
4. Connect galvanized and/or black pipe so that they will not leak.
5. Join or fit plastic pipe.
6. Sweat a copper joint.
7. Assemble cast iron pipe.

MOTIVATION:

Much time and money can be saved by knowing a few basic plumbing skills. To stop leaks in pipes, repair faucets, or make plumbing connections are skills that anybody could use to their advantage.

REFERENCES: Transparencies: "Kinds of Pipe Fittings 1, 2, 3,"
"Kinds of Valves 1, 2,"

OUTLINE:

A. Use of Pipe Fittings:
   1. To connect pipe
   2. Change direction of pipe
   3. Reduce size of pipe
   4. Plug pipes

B. Types of Fittings (see transparency masters)

C. Types of Valves:

1. Check valves
    - a. Prevent backflow of water
    - b. Automatic - open and close with direction of flow
2. Globe valves
    - a. Used to cut off flow or to drain the water line
    - b. Installed so that water pressure is under the valve seat to prevent leaking
3. Gate valve - similar to globe valve.
4. Waste valve - used to shut off pressure and drain the line.
5. Hydrant valve - similar to waste valve. Used to drain line from outlet back to valve to prevent freezing.
6. Safety valve
    - a. Attached to pressurized system
    - b. As pressure becomes too high the water is forced up against a spring held valve and escapes out a waste pipe.

D. Assembling Galvanized or Black Pipe and Fittings:

1. Should be assembled to avoid strains and bending at joints by using proper fittings.
2. Proper alignment of pipes is essential.
3. Use a thread compound:
    - a. Commercial tape, paste, or powder
    - b. Thick paint - for permanent work
    - c. Mixture of graphite and heavy grease
    - d. Mixture of portland cement and linseed oil
    - e. Applied to threads at end of pipe, or to threads inside fitting, or both
4. Screwing the joints tight:
    - a. The threads are tapered (the further the joint is turned the tighter the connection)
    - b. Turn just tight enough to prevent leaking
    - c. Can mar the fittings by turning too tight

E. Join or fit plastic pipe

1. Use two pieces of 1/2" plastic pipe cut to one foot lengths.
2. Clean pipe ends and coupling.
3. Spread cement evenly over inside of coupling.
4. Insert pipe and give 1/4 turn.
5. Let stand until dry.

F. Swenting a copper joint

1. Cut tubing to length.
2. Remove all burrs.
3. Clean surface by coating with flux and wiping clean.
4. Apply a thin even coat of flux.
5. Join tubing and fitting - give 1/4 turn.
6. Apply heat to heaviest part of fitting first then move to opening where solder enters.
7. Apply solder to the joint.
8. Wipe joint clean while solder is molten.

G. Assembling Tubing with Solder Fittings:

1. The copper tubing is cut square, and the burr is removed.
2. The outside area of the tubing that will be covered with the fitting is cleaned thoroughly.
3. The inside of the fitting is cleaned thoroughly.
4. Flux is applied to the cleaned portion of the tube.
5. The fitting is placed on the tubing, pushed against the shoulder of the fitting, and is turned several times to distribute the flux.
6. Heat is applied until the flux boils and the copper will melt solder.
7. Solder is applied until it appears completely around the edge of the fitting. Because of the close fit of the fitting and the pipe, the solder will flow by capillary action throughout the joint when the joint is properly heated. This action is in every direction - up, down, or sideways. The flame should be removed from the joint as quick as the joint is filled with solder. Execessive heat will cause the solder to boil out of the joint.
8. The joint is allowed to cool.

H. Assembling Cast Iron Pipe (Verticle Joint)

1. The hub is placed in an upright position.
2. The pipe and joint are cleaned, and the spigot end is placed into the hub its full depth.
3. Oakum, a form of rope, is wrapped around the pipe and packed with the yarning iron. The joint is filled within 3/4 inch from the top of the hub. The oakum must be packed tightly and evenly to make a water proof joint.
4. Molten lead is poured into and around the joint. Enough lead should be picked up in the ladle to fill the joint in one pouring.
5. The lead is allowed to cool, and then the joint is calked (packed) to make it water-tight. A hammer and calking iron are used for this.

1. Assembling Cast Iron Pipe (Horizontal Joint)

   Same as assembling verticle, except an asbestos joint runner is used to pour the lead in the hub.

TEACHING LEARNING ACTIVITIES:

1. Visit a plumbing supplies store and examine the kinds of pipe, fittings, valves, and other supplies available.
2. Have students make a list of equipment observed on the field trip.
3. Show the transparencies of fittings and valves while discussing the uses of plumbing supplies.
4. Have students study proper placement of unions and practice screwing fittings on by hand and tightening with a pipe wrench.
5. Hand out the worksheet on joining plastic pipe and allow students to practice fitting plastic pipe.
6. Review the worksheet on sweating a copper joint. Demonstrate the procedure and allow the students to practice sweating copper joints.

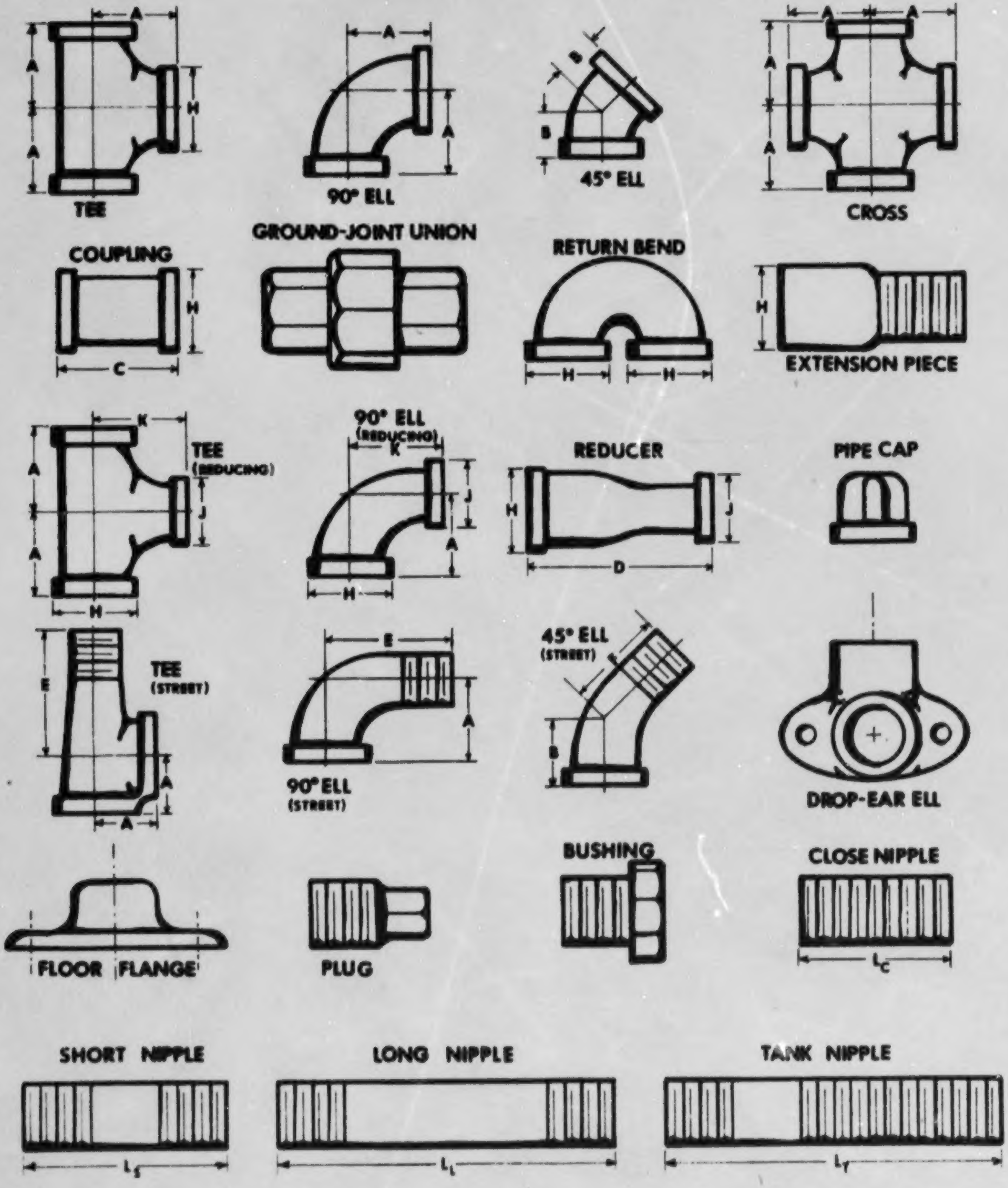
SUGGESTED EVALUATION:

1. Evaluate the students work activity in the shop.
2. Quiz students over material discussed in class.

V-139T

KINDS OF PIPE FITTINGS

STANDARD FITTINGS


TEE
A
H
90° ELL
45° ELL
B
CROSS
COUPLING
C
GROUND-JOINT UNION
RETURN BEND
EXTENSION PIECE
TEE (REDUCING)
K
J
90° ELL (REDUCING)
REDUCER
D
PIPE CAP
TEE (STREET)
E
90° ELL (STREET)
45° ELL (STREET)
DROP-EAR ELL
FLOOR FLANGE
PLUG
BUSHING
CLOSE NIPPLE
L_C
SHORT NIPPLE
L_S
LONG NIPPLE
L_L
TANK NIPPLE
L_T

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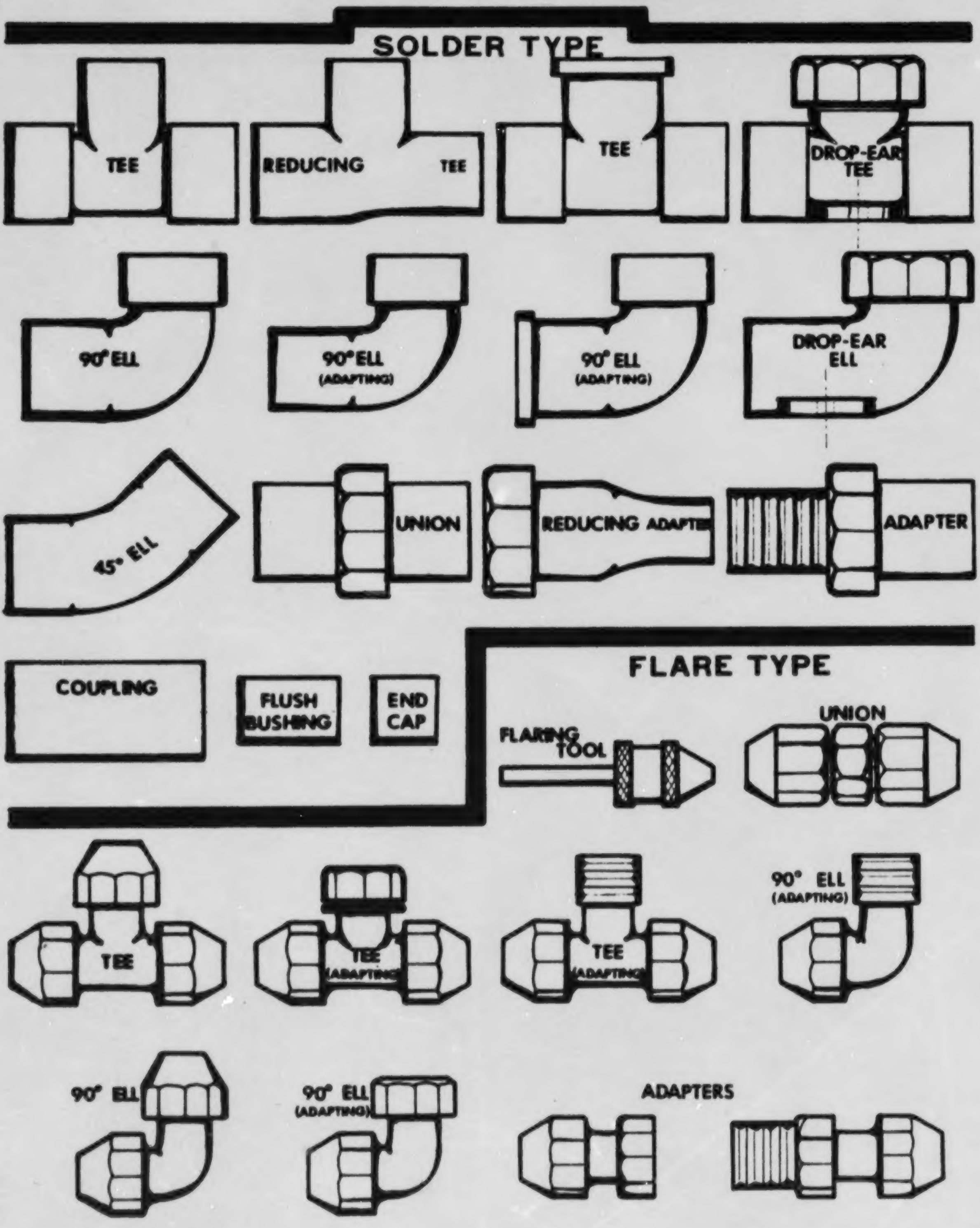
KINDS OF PIPE FITTINGS

V-140T

COPPER FITTINGS


SOLDER TYPE
TEE
REDUCING TEE
TEE
DROP-EAR TEE
90° ELL
90° ELL (ADAPTING)
90° ELL (ADAPTING)
DROP-EAR ELL
45° ELL
UNION
REDUCING ADAPTER
ADAPTER
COUPLING
FLUSH BUSHING
END CAP
FLARE TYPE
FLARING TOOL
UNION
TEE
TEE (ADAPTING)
TEE (ADAPTING)
90° ELL (ADAPTING)
90° ELL
90° ELL (ADAPTING)
ADAPTERS

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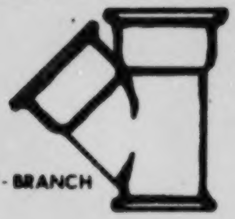
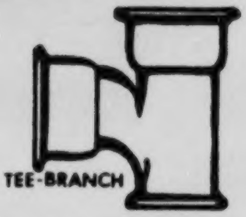
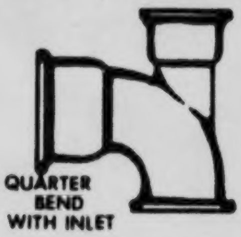
V-141T

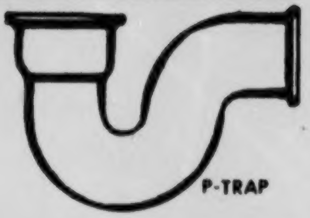
KINDS OF PIPE FITTINGS

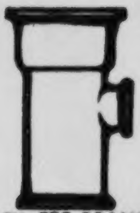
CAST IRON FITTINGS

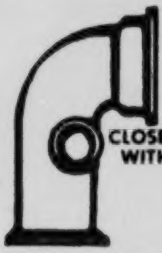

Y-BRANCH

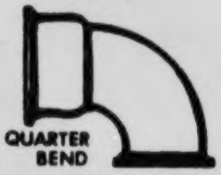

TEE-BRANCH

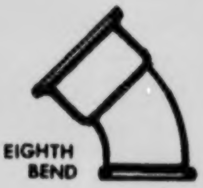

QUARTER BEND WITH INLET

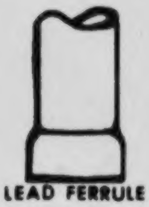

P-TRAP

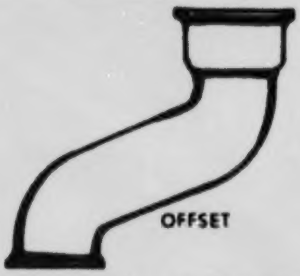

SANITARY TEE-BRANCH WITH TAPPED INLET


CLOSET BEND WITH INLET


QUARTER BEND


EIGHTH BEND


LEAD FERRULE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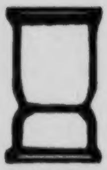
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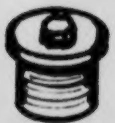
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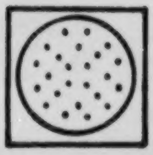
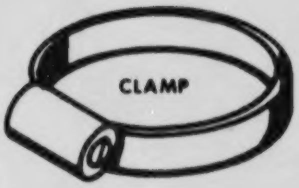

FLOOR DRAIN

PLASTIC FITTINGS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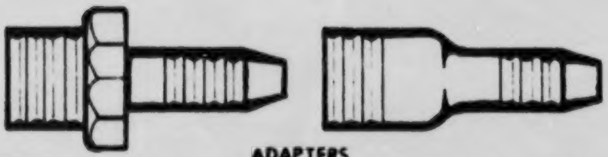
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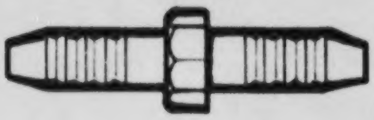
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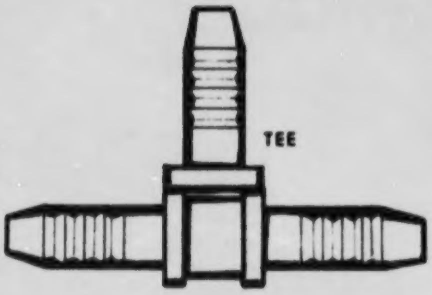
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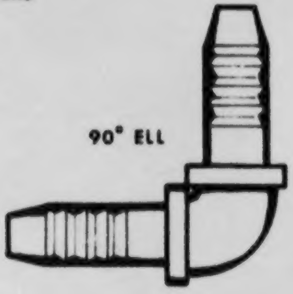
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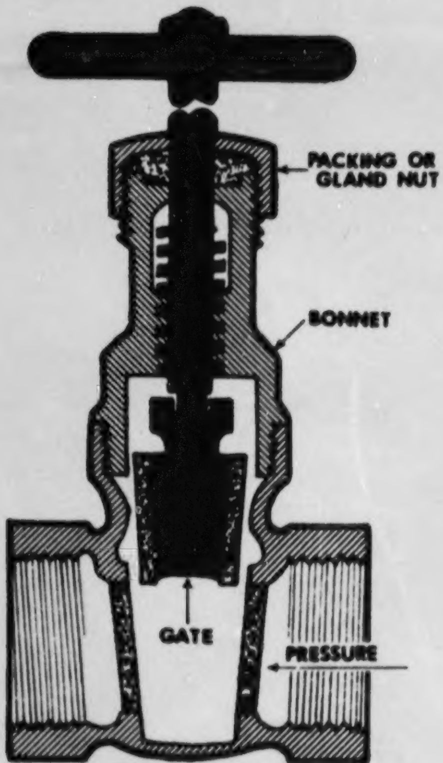
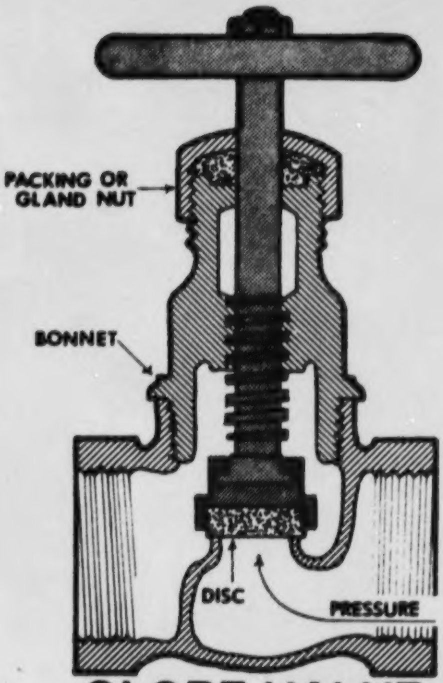
V-142T

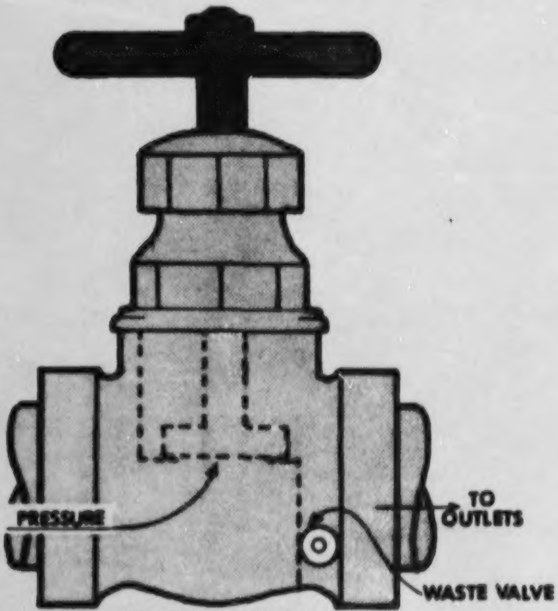
KINDS OF VALVES


PACKING OR GLAND NUT
BONNET
GATE
PRESSURE

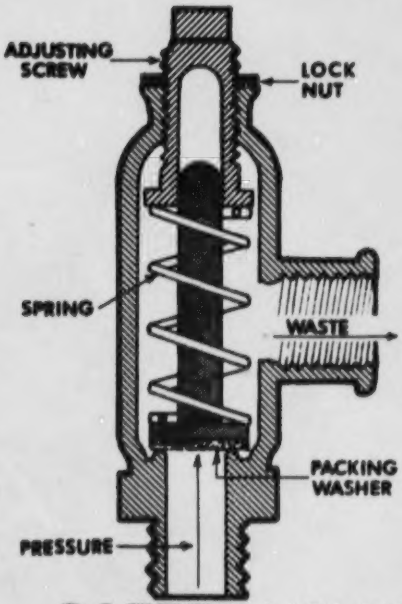
GATE VALVE


PACKING OR GLAND NUT
BONNET
DISC
PRESSURE

GLOBE VALVE


PRESSURE
TO OUTLETS
WASTE VALVE

WASTE VALVE


ADJUSTING SCREW
LOCK NUT
SPRING
WASTE
PACKING WASHER
PRESSURE

SAFETY VALVE

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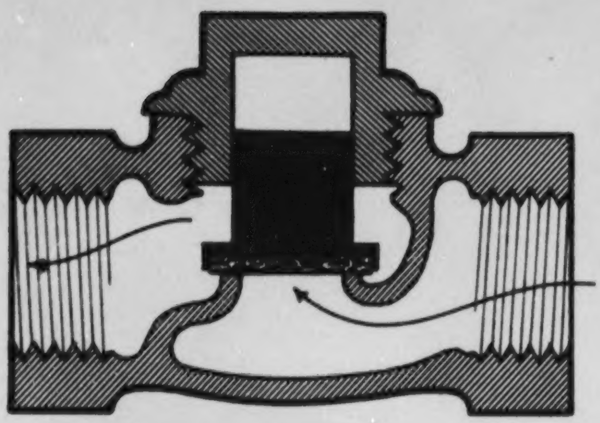
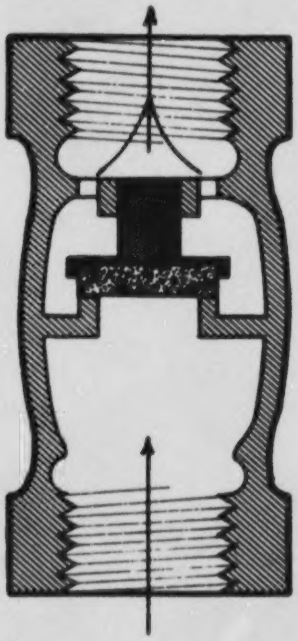
KINDS OF VALVES

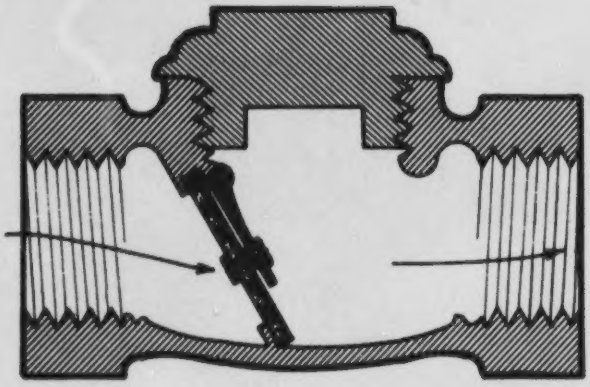
CHECK VALVES



HORIZONTAL CHECK



VERTICAL CHECK



SWING CHECK

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LESSON 21: FUNDAMENTALS OF ELECTRICITY

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List benefits derived from the use of electricity.
2. Define common electrical terms.
3. Discuss the phenomenon of electrical energy.
4. Describe, in writing, four basic sources of electricity.
5. Name the electricity suppliers that service an area.
6. List the four means of transporting electricity.
7. Write a brief description of the transformer including its means of operation.
8. Draw a circuit diagram showing a series and a parallel arrangement.
9. Discuss how heat, light, and power is derived from electricity.
10. Read an electrical meter and calculate the kilowatt-hours using the residential rate.
11. Calculate the kilowatt-hours for operating an electrical motor for a given number of hours.
12. Calculate problems determing volts, amps, and watts.

MOTIVATION:

Have students list items that are operated by electricity. Categorize each item into heat, light, mechanical, magnetic or electrochemical.

REFERENCES:

Transparency Masters: "How Electricity Gets to the Farm"

OUTLINE:

A. Benefits from Electricity:

1. Heat - heating lamps and heating coils, stoves
2. Light - light bulbs
3. Mechanical power - electric motors
4. Magnetic force - electromagnet in motors
5. Electrochemical - plating of metals

B. ELECTRICAL TERMS:

1. Electricity - a source of energy converted into light, heat, or power.
2. Ampere (Amp) - a unit of measure of the rate of flow of electricity through a wire.
3. Volt - a unit of measure of electrical pressure.
4. Watt - a unit of measure used in determining the rate of energy supplied.
5. Watt-hour - one watt for one hour.
6. Kilowatt (KW) - 1,000 watts.
7. Kilowatt-hour - the use of 1,000 watts of electricity for one hour.
8. Horsepower (hp) - a unit of mechnical power which is equal to 746 watts of electrical power.
9. Direct current (DC) - the term meaning that the current flows in one direction at a continuous rate.
10. Alternating current (AC) - the term meaning that the current reverses direction at regular intervals.
11. Circuit - a complete path through which electricity flows, such as from the power source to a light through the light and back to the power source.

12. Switch - used to open or close a circuit.

13. Fuse - safety device which burns out when the current becomes too great.

14. Circuit breaker - a safety device which opens the circuit by tripping a switch rather than burning.

15. Conductors - the wires which carry the electricity, or through which electricity flows.

16. Insulation - a protective covering over wires to prevent completing a circuit except where desired.

17. Hot wires - the current carrying conductors with electrical pressure on them (usually black or red) connected to fuse or circuit breaker at distribution panel.

18. Neutral wires - the current carrying conductors with no pressure on them (usually white) connected to neutral base at the distribution panel.

19. Grounding - the connection of the neutral part of the electrical system to the earth to reduce the possibility of damage from lightning, and the connection of the housings of electrical equipment to the earth to minimize the danger of electrical shock.

20. Short circuit - an improper connection between hot and neutral wires or between hot wires.

21. Voltage drop - a loss in electrical pressure from its source to its point of use.

22. U.L. (Underwriter's Laboratories) - a nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet minimum standards for safety and quality.

C. Electrical Energy:

1. Present in atoms of all materials.
2. In atoms are positive charged protons and negative charged electrons.
3. When positives and negatives are in equal supply, no electricity exists.
4. Force causing the loss of balance between charged forces makes it possible for the electric current to flow.

5. Electrical energy is released from atoms.

D. Four Basic Electricity Sources:

   1. Heat (thermocouple):

      a. Two wires of different material are connected to form a circuit
      b. The coupling point is heated or cooled causing an electrical current

   2. Friction - produced by rubbing certain materials together (rubber comb with a wool cloth)

   3. Chemical action:

      a. Some metals readily release electrons (zinc)
      b. Strip of zinc and a strip of copper are placed in dilute sulfuric acid
      c. Electrons flow from zinc to copper
      d. If strips are connected by a wire an electrical circuit is developed representing a one-cell battery

   4. Magnetism - most common way electricity is generated:

      a. Coil of copper wire rotated in a magnetic field in such a way as to cut across lines of magnetic force will induce an electrical current

E. OHM'S Law - All electric circuits have a definite relationship between the pressure, the electron motion, and the opposition:

   1. Voltage - current = resistance

   2. Voltage - E volts

   3. Current - I amps

   4. Resistance - R ohms

F. Electrical Suppliers:

   1. REA Cooperative

   2. Public or private companies

G. Means of Transporting Electricity:

1. Transmission lines - lines from generating station to substation or from substation to substation.

2. Distribution lines - lines beginning at a substation and extending out over the countryside, ranging from three to fifteen miles.

3. Service drop lines - lines from the distribution line to the meter pole.

4. Feeder lines - from meter pole to house:

   a. Two lines running to house - 115 volt service
   b. Three lines running to house - 230 volt service

H. Transformer:

1. Used to step up or reduce voltage.

2. Made of soft iron core around which is wound the wire coming from the source of current and the wire going out carrying the induced current.

3. Incoming wire is primary winding and wire carrying induced current is the secondary winding.

4. The turns in the wire wrapped around the iron reflect the ratio in which the current is lowered or raised.

5. The electricity on the distribution lines would be 7200 volts and the electricity on the service drop lines would be reduced to 115 volts and 230 volts with windings of fewer turns.

I. Getting Heat From Electricity:

1. Generated by the resistance of a wire to the electric current passing through it.

2. Alloys of iron with nickel, chromium or other metals that can provide a high degree of resistance but with high melting points are used as elements for heating.

J. Getting Light from Electricity:

1. Light is produced by heating metal white hot.

2. Usually tungsten (high melting point) is used for incandescent lights.

3. A vacuum is formed with the glass to keep the element from oxidizing or burning up.

4. The filament slowly vaporizes becoming smaller, until it breaks depositing the vaporized metal on the glass. (Electric bulb life approximately 1,000 hours.)

5. Flourescent lights - small filament in each end with mercury in the tube.

   a. Filaments heat and vaporize the mercury
   b. The current arcs from one filament to the other and produces ultraviolet light
   c. The ultraviolet light hits a phosphorous powder which converts the ultraviolet light to visible light

K. Getting Power from Electricity:

1. Electric motor is a duplicate generator but instead of using mechanical energy to make electricity it is converting electricity to mechanical energy.

2. Motor has two basic parts, a stator and a rotor:

   a. Stator - stationary windings of copper wire on laminated sections of iron to form the poles of an electromagnet
   b. Rotor - also electromagnetic device that is free to rotate
   c. Magnetic forces cause the rotor to turn when the stator coils are energized

L. Calculate Kilowatt-Hours:

1. Calculating residential rates with electric water heater

a.	first	12	Kwh's	at	$2,45total
b.	next	88	Kwh's	at	$5.81 per Kwh
c.	next	100	Kwh's	at	$4.13 per Kwh
d.	next	400	Kwh's	at	$2.66 per Kwh
e.	next	400	Kwh's	at	$2.46 per Kwh
f.	over	1000	Kwh's	at	$1.77 per Kwh

Note: cost does not include tax or fuel adjustment

2. Customer Used 1600 Kwh's

a.	first	12	Kwh's	at	$2.95 = $2.95
b.	next	88	Kwh's	at	$5.81 = $5.12
c.	next	100	Kwh's	at	$4.13 = $4.13
d.	next	400	Kwh's	at	$2.66 =$10.64
e.	next	400	Kwh's	at	$2.46 = $9.84
f.	next	600	Kwh's	at	$1.77 =$10.62

Total cost of 1600 Kwh's = $43.30

M. Cost of Operating Electrical Equipment:

1. Watts x hours of operation = Watt-hours

2. Kilowatt-hours (kwh) = $\frac{\text{Watts x Hours}}{1000}$

250

3. Motors:

   a. Multiply 1,200 by hp rating if motor is smaller than one-half hp
   b. Multiply 1,000 by hp rating if motor is one-half or greater
   c. Example:

      a. 1/4 hp motor x 1,200 = 300 watts
      b. 300 watts x 2 hours of operation = 600 watt-hours
      c. $\frac{600}{1000}$ = .6 kwh's

TEACHING LEARNING ACTIVITIES:

1. Use the motivation to begin this lesson.

2. Make up and hand out a list of electrical terms and review this list with the students.

3. Lead discussion in how electricity operates and is transported through wire.

4. Discuss how different materials hold different resistance values and explain ohm's law.

5. Ask students what are four ways electricity can be produced.

6. Show the transparency of "Electrical Transporting Lines." Ask students who supplies the electricity. Discuss how electricity is transported. Include names of lines in the discussion.

7. Ask the class how voltage can be increased or decreased. Tell them that the voltage is much higher on the distribution lines than it is in the house. Explain the operation of the transformer.

8. Draw a circuit in series and one in parallel arrangement. Have class figure which is most commonly used in the house and why. Write down their answers. Discuss their answers in class.

9. Discuss with class the operation of heat, light, and mechanical power and how they are derived from electricity. Use examples of heating coils, lights and motors to aid in discussion.

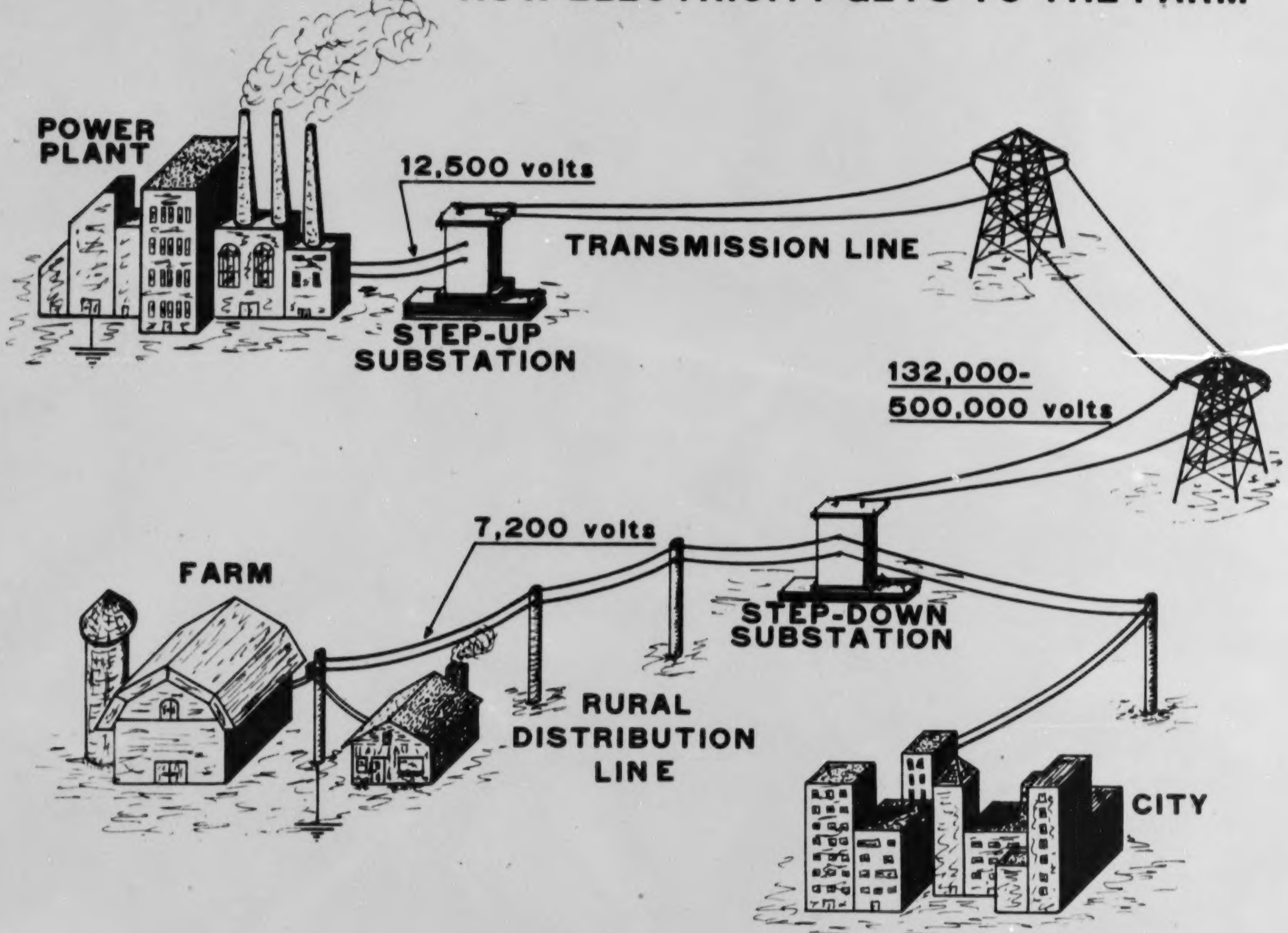
10. Show examples of electric meters and explain how to read them. (See your electric utility representative)
11. Give an example of how electrical billing is determined and have students figure the amount of the bill.

12. Give examples of calculating kilowatt-hours and figuring volts, amps, and watts.

SUGGESTED EVALUATION:

1. Evaluation of problems worked from the assignments.
2. Written quiz covering material discussed.

HOW ELECTRICITY GETS TO THE FARM


POWER PLANT
12,500 volts
TRANSMISSION LINE
STEP-UP SUBSTATION
132,000-500,000 volts
7,200 volts
FARM
STEP-DOWN SUBSTATION
RURAL DISTRIBUTION LINE
CITY

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V-152T

LESSON 22: ELECTRICAL SAFETY

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Name two major causes of electrical accidents.
2. Describe electrical defects that could cause hazards.
3. List the one factor that contributes to death due to electrical shock.
4. List three methods of freeing a person from an electrical shock.
5. Describe, in writing, the type of first aid to be given to a person that has received an electrical shock.
6. Select the proper types of fire extinguishers to use in controlling fire.
7. List signs that indicate wiring is out of date.
8. List four types of circuit protection equipment when samples are provided for identification.
9. Survey the home, business or farm for safe and unsafe electrical conditions.

MOTIVATION:

Talk about the seriousness and the extreme dangers that are related to working with "live" electricity. Emphasize the necessity of practicing safe methods when working with electricity. Less than 1/4 ampere will stop the heart.

REFERENCES:

Handouts: "Electrical Conditions Survey"

OUTLINE:

A. Two Causes of Electrical Accidents:

1. Misuse

2. Carelessness

B. Hazardous Electrical Defects:

1. Ground wire improperly connected, not connected, missing or broken.

2. Worn, wet, or oily insulation (short circuit).

3. Open conduits; damaged or worn switch boxes.

4. Defective switches, receptacles, extension or lamp cords, and lamp sockets.

5. Loose vibrating machine parts (causing short circuits).

6. Dirty, maladjusted electrical equipment.

C. Factor Contributing to Death From Shock:

1. Current kills (not voltage).

2. Voltage is involved.

3. Less than 1/4 amp will stop the heart. (Current flowing in a 25-watt lamp at 115 volts is enough to stop heart of an average man.)

D. Methods of Freeing Person From Electrical Shock:

1. Locate source of electrical current and disconnect.

2. Decide immediately whether it would be easier to move the person or the conductor.

   a. use dry stick to move conductor
   b. use paper or cloth in hand and grasp the person's arm or leg and quickly pull him free of the conductor. (The above methods to be used on 120-240 volts)

E. First Aid for an Electrical Shocked Victim:

1. Call doctor or ambulance.

2. Mouth to mouth resuscitation

F. Fire Extinguishers for Electrical Fires:

1. Do not use water unless electric current is disconnected.

2. Electrical fires are class C - use extinguishers recommended for class C fires.

    a. Carbon dioxide
    b. Dry chemical

G. Signs of Out-Of-Date Wiring.

1. Fuses blow

2. Circuits trip

3. Lights dim, blink, flicker

4. Television picture wobbles

5. Appliances require longer to heat

6. Air conditioner not functioning up to full power

7. Motor slow to come up to normal speed.

H. Types of Circuit Protection Equipment

1. Fuse - safety device breaks current flow when circuit is overloaded.

    a. Plug
    b. Cartridge
    c. Blade

2. Fusetron - double element time delay fuse designed to withstand momentary overloads.

3. Fustat - time delay action similar to fusetron.

4. Circuit breaker - excess flow causes the heater strip to heat the bi-metal strip which trips the breaker.

TEACHING LEARNING ACTIVITIES:

1. Discuss with class what two major reasons electrical accidents occur.

2. What are some hazards that could cause accidents? Have students develop a list of problems.

3. What is it about electricity that can kill a person? Discuss this question with the class.

4. What would you do if somebody was being shocked? Discuss methods of freeing a person from an electrical shock.

5. What should be done for a person injured from electrical shock? Discuss the first aid steps needed.

6. If you had a fire started by electricity what type of fire extinguisher would you use? Discuss the class of fire and the extinguishers to use. Why not use water? Explain the fact that water is a conductor.

7. Have students develop ideas on how a person can tell if a house needs rewiring.

8. Show examples and explain the function of different types of circuit protection equipment.

9. Have students work in groups and prepare a list of items that should be checked in the business or home for electrical safety or hazards. See how the list compares to the work sheet.

10. Have the students run an electrical safety check on their homes or businesses.

SUGGESTED EVALUATION:

1. Evaluate students class assignments.

2. Provide a written quiz covering material discussed during class.

ELECTRICAL CONDITIONS SURVEY

Answer yes or no to the following questions if they apply to your situation.

1. Do fuses blow and/or breakers trip when appliances are connected? (indicates circuit overloaded)
2. Are all appliances U.L. (Underwriters' Laboratories) approved?
3. Is the television set away from curtains?
4. Do lamps touch the wall?
5. Are lamps touching curtains or other flamable materials?
6. Are cords under rugs?
7. Are cords against heaters or heating vents?
8. Is the television set well ventilated?
9. Are cords showing signs of wear?
10. Do switches work properly?
11. Are there enough electrical outlets?
12. Have fuses or circuit breakers been tempered with?
13. Is the main switch clean and in good repair?
14. Are light cords hung over nails?
15. Is the lamp cord wrapped around bed posts or fastened to woodwork?
16. Are lamp cords removed from walking areas?
17. Will clothing touch the lights or light fixtures?
18. Are electric motors free of lint or oil?
19. Are wires strung through doors?
20. Are extra fuses kept on hand?
21. Is the ventilating fan clean?
22. Are electrical outlets broken?
23. Are overhead wires supported and clear of machinery?
24. Are all outbuildings properly grounded (lightning protection)?

LESSON 23: ELECTRICAL WIRING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Select the conductors to be used.
2. Select tools used for wiring.
3. List factors that contribute to voltage drop.
4. Select electrical equipment from examples and diagrams to match the names of each piece of equipment.
5. List three requirements for a wiring system.
6. Perform basic wiring of lighting outlets, switches, and receptacles.
7. Match electrical symbols with their names.
8. List requirements for planning the wiring layouts for different types of rooms in a house.
9. List three classifications for branch circuits.
10. Figure the number of branch circuits for a given situation.
11. Select the proper service entrance switch for a given situation.
12. Select the proper wire size for branch circuits.
13. Design a wiring diagram for a selected house by using the floor plan diagram.

MOTIVATION:

Have students wire basic circuits to give them a basic knowledge of wiring.

REFERENCES:

Handouts: "Maintaining the Lighting and Wiring System" AAVIM
"Agricultural Wiring Handbook" Edison Electric Institute
"Electrical Wiring" Sears

Transparency Masters: "Graphical Electrical Symbols"

OUTLINE:

A. Conductors:

NO. ITEM	TYPE	AM. WIRE GAUGE	USE
1. Cable	Triplex	6/3	Outside-Overhead Service
2. Wire	USE	10	Trench-Lay - Under Ground
3. Cable	UF	10/2	Underground-Feeder and Branch Circuits
4. Cord	S	12/3	Hard Usage-Welders Large Motors
5. Wire	TW(140 1/4)	14	Inside of Conduit Dry and Wet Locations
6. Cable	NM	14/2G	Inside-Dry Locations
7. Cord	HC	16/2	Iron, Heaters
8. Cord	HPN	16/2	Heater Cord
9. Wire	A(392 1/4)	16STD	Heating Appliances With-In Apparatus-Dry Locations
10. Wire	TWO (Low Voltage)	18	Low Voltage Alarm or Relay Controls
11. Cord	SJ		
11. Cord	SJ	18/2	Portable Tools
12. Cord	SV	18/2	Vacuum Cleaners - Mixures

B. Voltage Drop Factors:

1. Length of wire.
2. Size of wire.
3. Number of amps flowing through wire.
4. Type of conductor.

C. Electrical Devices:

1. Single element fuse, 30-amp, Edison plug type.
2. Time delay fuse, 25-amp, Edison plug type.
3. Time delay fuse, 40-amp, cartridge type.
4. Single element fuse, 50-amp, cartridge type.
5. 1/2" connector for NM cable.
6. 15-amp duplex, 115/230-V, grounded receptacle, 3-wire.
7. 15-amp, duplex, 115-V, grounded receptacle, 3-wire.
8. 50-amp, 115/230-V, cord receptacle cap.
9. 50-amp, surface receptacle, 3-wire, 115/23--V.
10. 3-wire receptacle, 30-amp, 115/230-V., twist lock.
11. Single-pole, single-throw, toggle wall switch.
12. Single-pole, 3-way, toggle wall switch.
13. Crow foot polarized cord cap, 20-amp, 3-wire, 230-V.
14. Polarized tiwst lock plug cap, 20-amp, 115/230-V., 3-sire.
15. Handy box 1/2" knock-out and cover for toggle switch.
16. Handy box 1/2" knock-out and cover for duplex receptacle.
17. Wall box with clamps, and beveled corners for switch or receptacle.
18. 4" x 1 1/2" octagon box, 1/2" knock-outs for ceiling outlets or junction box.

D. Three requirements for a wiring system:

1. Safe - wire sizes that satisfy safe ampere capacity and fused properly - installed according to the National Electric Code.
2. Adequate:
   a. Provide convenience in the number and location of receptacles (outlets) and switches.
   b. Sufficient voltage to all appliances - no more than 2% voltage drop for lighting and heating appliances and no more than 3% voltage drop for motors.

c. Have adequate number of circuits to supply present and anticipated needs

3. Economical - safe and adequate at minimum cost.

E. Electrical Symbols (see transparency)

F. Planning Convenience Outlets"

1. Living room and bedrooms:

   a. One or more ceiling lights.
   b. Duplex outlets spaced 12 feet apart around wall.

2. Dining room.

   a. One or more ceilinglights.
   b. Duplex outlets paced 12 feet apart.

3. Kitchen.

   a. One or more ceiling lights.
   b. One ceiling light or wall light located over sink.
   c. Special purpose outlets for range, dishwasher, disposal, and for items over 1/3 hp.
   d. Duplex outlets spaced every four feet of kitchen work surface.
   e. At least one duplex outlet for each usable wall space not previously used. Outlets no more than 12 feet apart or no point over 6 feet away from outlet.

4. Laundry and utility room:

   a. One or more ceiling outlet
   b. Duplex grounding outlets for miscellaneous use.
   c. Special purpose outlets for dryer, water heater, and furnace.

5. Bathrooms:

   a. One or more lighting outlets located at mirror.
   b. Duplex outlet near mirror.

6. Exterior entrances:
   a. One lighting outlet at back and front of house, controlled by indoor wall switch.
   b. One single weatherproof outlet located at front and one at back of house.

7. Halls:
   a. One ceiling outlet, controlled by 3 way switch.

8. Stairways and closets:
   a. One lighting outlet for each floor, controlled by 2 way wall switch.

G. Branch Circuit Classification and Requirements:

1. Individual equipment (special purpose)
   a. One branch circuit for each special outlet
   b. Motors of 1/3 horsepower and larger

2. 20-amp small appliance:
   a. Three circuits per house
   b. Three outlets per small appliance circuit
   c. Located in kitchen, laundry room, pantry, dining room, breakfast room
   d. Add number of outlets, divide by three, count any fraction as a while

3. 20-amp general purpose:
   a. One branch circuit for each 500 square feet of floor space
   b. Nine outlets per general purpose circuit
   c. Add total number of outlets, divide by 9, count any fraction as a while without adding receptacles in utility room, kitchen, or dining room.

H. Service Entrance Switch:

1. Minimum size allowed for entrance is 100-amp

2. Add the total wattage and divide by 230 volts to equal the total for the service entrance.

3. Standard sizes: 100, 125, 150, and 200 amps

I. Sizes of wires:

Wire Size AWG Number	Wire Rating AMP
14	14
12	20
10	30
8	40
6	50
4	70
3	80
2	95
1	110
1/0	125
2/0	145
3/0	165
4/0	195

J. Branch circuit wires with appliances

	Rating	Wire Size AWG	Wire Rating in amps	Maximum Device in amps
Branch Circuit:				
20-amp General and small appliance	20 amp	12	20	20
range	16,000 watts	6	50	50 or 60
heater	4,500 watts	10	30	30
freezer	200 watts	12	20	20
washing machine	400 watts	12	20	20

Note: The ratings are standard estimates. Check the manufacturer's rating on individual appliances.

TEACHING LEARNING ACTIVITIES:

1. Review with the class the different types of conductors that can be used and their recommended uses. Contact an electrician or electrical supply outlet to see if samples can be made available for identification.

2. Provide samples of tools used for electrical wiring.

3. Ask class what is meant by the term voltage drop. Explain the meaning and what factors contribute to voltage drop.

4. Review electrical equipment and uses with the students. Provide samples for students to see.

5. Ask students what the three most important considerations to a wiring system should be. Discuss the answers of each student and how they relate to the outline information.

6. Demonstrate the process of wiring a single pole switch. Review the steps to be taken for construction of the circuits in each of the assignments.

7. Have students assemble the circuits and check their work before the power source is connected.

8. Review information on requirements for wiring different rooms of a house.

9. Discuss the different classifications for branch circuits and how each is set up.

10. Discuss service entrance switches and their requirements.

11. Set up a sample problem for students to figure the number of branch circuits required in an example.

12. Discuss wire sizes and how to figure sizes required for particular circuits.

13. Bring in a floor plan of a house showing the wiring diagram. Have students identify the symbols used and locate the different circuits and their loads.

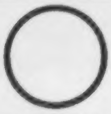
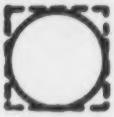
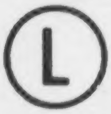
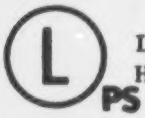
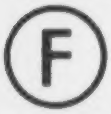
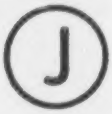
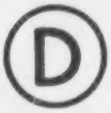
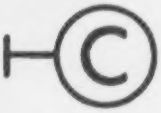
SUGGESTED EVALUATION:

1. Evaluate assignments students have complete.
2. Quiz the students over the technical information discussed from the lesson.

V-166T

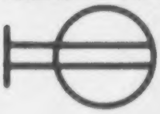
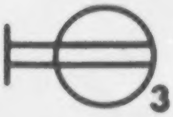
GRAPHICAL ELECTRICAL SYMBOLS

GENERAL OUTLETS

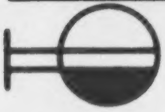
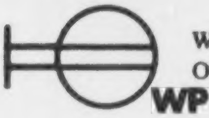
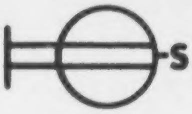
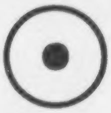
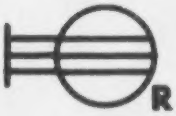
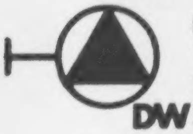
	LIGHTING OUTLET
	CEILING LIGHTING OUTLET FOR RECESSED FIXTURE (OUTLINE SHOWS SHAPE OF FIXTURE.)
	LIGHTING OUTLET WITH LAMP HOLDER
	LIGHTING OUTLET WITH LAMP HOLDER AND PULL SWITCH
	FAN OUTLET
	JUNCTION BOX
	DROP-CORD EQUIPPED OUTLET
	CLOCK OUTLET

TO INDICATE WALL INSTALLATION OF ABOVE OUTLETS, PLACE CIRCLE NEAR WALL AND CONNECT WITH LINE AS SHOWN FOR CLOCK OUTLET.

CONVENIENCE OUTLETS

	DUPLEX CONVENIENCE OUTLET (GROUNDING TYPE OUTLET REQUIRED)
	TRIPLEX CONVENIENCE OUTLET (SUBSTITUTE OTHER NUMBERS FOR OTHER VARIATIONS IN NUMBER OF PLUG POSITIONS, SUCH AS 1 FOR SINGLE CONVENIENCE OUTLET)

CONVENIENCE OUTLETS (Cont.)

	DUPLEX CONVENIENCE OUTLET-SPLIT WIRED
	WEATHERPROOF CONVENIENCE OUTLET
	COMBINATION SWITCH AND CONVENIENCE OUTLET
	FLOOR OUTLET
	RANGE OUTLET
	SPECIAL-PURPOSE OUTLET. USE SUBSCRIPT LETTERS TO INDICATE FUNCTION. DW-DISHWASHER, CD-CLOTHES DRYER, ETC.

SWITCH OUTLETS

S	SINGLE-POLE SWITCH
S_2	DOUBLE-POLE SWITCH
S_3	THREE-WAY SWITCH
S_4	FOUR-WAY SWITCH
S_D	AUTOMATIC DOOR SWITCH
S_P	SWITCH AND PILOT LIGHT
S_{WP}	WEATHERPROOF SWITCH

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

LESSON 24: PLANNING A SERVICE CENTER

OBJECTIVES:

At the completion of the lessor the student will be able to:

1. Plan the size of shop needed for the students operation.
2. Plan the shop electrical needs.
3. Develop a plan for fire protection.
4. Store fuel in a safe place.
5. List general safety practices to be observed in the shop.

MOTIVATION:

To have a well-planned shop means to have tools where you can find them. It provides you a place to work during inclement weather. It is arranged so that work is more organized and efficient. A well-planned shop reflects good management practices in all areas.

REFERENCES:

Shopwork on the Farm, McGraw-Hill Book Co.

Farm Fire Safety for Vocational Agriculture Instruction, I.C.M.C.

OUTLINE:

A. Size of Service Center:

  1. Shop is built in conjunction with machinery storage, headhouse space, or garage. Machinery can be repaired in the storage area.
  2. Shop space:
     a. About 14 by 20 feet is usually sufficient when connected to machinery storage.
     b. Pole barn construction - use one end as a shop (EXAMPLE: 48' wide pole barn with 32' length for shop area.)

B. Design of the Service Center:

1. Building materials:
    a. Pole barn construction with baked-on enamel painted metal sheets is popular
    b. Pole barns with galvanized steel siding and roofing
    c. Concrete form walls or block walls can be used

2. Should have windows for light and ventilation:
    a. At least on two sides - possibly three
    b. Place one window over the workbench
    c. Place a window over each vice - so two windows over the workbench in this situation
    d. Total of at least four windows 20 x 36 inches dimension each

3. Doors:
    a. At least one large overhead door
    b. In pole barn construction - some shops are designed with one overhead or sliding door to the outside and directly across the shop another overhead or sliding door into the machinery storage area
    c. One walk in door from the outside 2'8" wide and 7' high

4. Flooring:
    a. Concrete floors where all of the repair work is to be done
    b. Gravel in machinery storage area

C. Wiring the Service Center:

1. Install a 60 ampere sub panel from the main panel to supply the needed electricity.

2. Have at least four circuits.

3. Three 110-volt circuits for small appliances

4. One 230-volt circuit for an electric welder and motors larger than 1/2 horsepower.

5. Use ceiling lights controlled by a wall switch near door.

6. Place lights over workbench, welder, table saws, etc.

7. Place outlets at work centers.

8. Put connection for welder near door so work can be done outside the shop.

9. Install an outside light to light the shop entrance.

D. Fire Protection:

1. Ventilation of the area should be used to remove inflamable fumes.

2. Only small quantities of gasoline should be kept in the shop in tightly closed metal containers.

3. Oily rags should be stored in metal containers.

4. Pails or boxes of sand should be available for extinguishing oil fires.

5. At least one fire extinguisher should be located in easy to reach area.

E. Fuel Storage:

1. Gasoline is best stored underground:

   a. Located so no weight of buildings or roadways should be over the storage
   b. Mount on firm foundation
   c. Fill tank opening should be at least 60 feet from the building

2. Storage tanks above ground:

   a. Storage tanks designed for type of fuel stored.
   b. Post warning signs
   c. Place at least 40 feet from building
   d. Label tanks
   e. Ventilate tanks to allow for vapors to escape
   f. Lock the tanks to prevent tampering
   g. Ground the tanks to prevent sparks from igniting fumes.

G. General Shop Safety Practices:

1. Practice good shop housekeeping.

2. Protect yourself against injury:

   a. Plan storage
   b. Be alert to general safety around machinery

3. Keep tools in good working condition.

4. Keep guards over belts, pulleys, and gears.

TEACHING LEARNING ACTIVITIES:

1. Discuss the different considerations to make in determining what size service center to plan.
2. Have students make a list of features that should be included in designing a service center.
3. Discuss the list of features and decide on best designs. Draw a rough sketch of the design on the board.
4. Have students search reference materials on electricity or the reference text to determine electrical needs for the service center.
5. Assign students to design shop dimensions and a basic plan on graph paper.
6. Have students discuss their designs in class.
7. Present to class information from Teaching Units in Farm Fire Safety, teaching unit III.
8. Have class develop a list of general safety practices to use in the shop.

SUGGESTED EVALUATION:

1. Evaluate students' assigned work.
2. Quiz students over discussion information.
3. Assign grades to quiz in Farm Fire Safety for Vocational Agriculture Instruction.

LESSON 25: SELECTING AND STORING TOOLS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Select tools that best fit the student's needs.
2. Plan storage cabinets and racks and benches.
3. Arrange the shop for best storage and working areas.

MOTIVATION:

Shops should be arranged for the most efficient use of space. Tool storage should be planned so that access to tools is easy. What tools should your shop contain?

REFERENCES:

Shopwork on the Farm, McGraw-Hill Co.

OUTLINE:

A. Basic Tools for the Shop:

1. Basic hand tools: (examples)
    - a. Steel square
    - b. Folding or sliding rule
    - c. Crosscut saw and ripsaw
    - d. Brace and bits
    - e. Hack saw
    - f. Screw drivers - Phillips and Standard
    - g. Wrenches - combination, adjustable, pipe wrench
    - h. Socket set - 1/2" drive or 3/8" drive, 1/4" drive
    - i. Pliers - fencing pliers, long-nosed pliers, channel lock pliers, combination pliers
    - j. Hammers - curved claw hammer, ball peen hammer
    - k. Files - rat-tail, flat file, round file
    - l. Wrecking bar
    - m. Jack plane
    - n. Bench vise

2. Power tools: (examples)
    a. Grinder
    b. Portable electric drill and set of bits
    c. Electric arc welder or oxyacetylene welder
    d. Electric hand saw, electric jig saw
    e. Power hack saw
    f. Drill press
    g. Air compressor

3. Other tools:
    a. Floor jack
    b. Hoist
    c. Threading and plumbing tools
    d. Lathe
    e. Anvil
    f. Special types of vises

B. Shop Equipment Benches and Storage:

1. Workbenches:
    a. Stationary workbenches - built into wall using wall studs for support
    b. Use 2 in. lumber for top and legs - fasten together with bolts or screws
    c. 24 to 30 inches wide and 30 to 34 inches high
    d. Build 6 to 12 feet long
    e. Portable bench with small wheels at one end 3 feet long, 20 inches wide and 32 inches high

2. Closed tool cabinets:
    a. Used for smaller more expensive tools - locked and keeps dirt out
    b. Hooks, racks and shelves are arranged inside the cabinets

3. Tool boards:
    a. Open boards used to hang tools for easy access
    b. Paint silhouettes of each tool for aid in replacing tools

4. Small bins or drawer cabinets used for storing fasteners. Screws can be kept in glass jars.

5. Fastener storage wheel:
    a. Wheel cut from plywood
    b. Jar lids attached to wheel
    c. Jars containing small items are fastened to the lids
    d. Wheel fastened to the wall

6. Lumber storage:
    a. Racks along walls
    b. Overhead storage
    c. Large amounts of lumber stored in place other than shop

7. Steel storage:
    a. Stored by standing on end
    b. Rack along wall with compartments for different sizes of metal

8. Storage of papers:
    a. Store catalogs, instruction books, repair parts lists, notebooks, paper, and maintenance sheets
    b. Use small cabinet, set of drawers, or desk
    c. Use storage that is mouse proof

C. Shop Arrangement:

1. Open central area to repair machinery.

2. Locate work benches beneath windows.

3. Arrange tools and supplies in areas to be used:
    a. Wood-working tools and wood storage in a selected area for wood-working
    b. Metal for welding and special welding table and equipment near the door at the welder
    c. Other metal working equipment - power hack saw, drill press should be arranged in the same area

4. Build metal and wood storage racks along walls.

5. Plan overhead storage of materials

6. Provide for lighting and an electrical outlet in each work area.

7. Build a portable work bench to move to the work area.

TEACHING LEARNING ACTIVITIES:

1. Have students make up a list of tools that should be included in the shop.

2. Review the lists and discuss during class.

3. Discuss with the class the types of benches and storage equipment needed in the shop.

4. Review with the students specific plans for building work benches and storage cabinets.

5. Have students develop work bench and/or tool cabinet building plans. (Refer to Agribusiness I Lesson: Drawing and Sketching)

6. From the plans drawn up have students write their bills of materials.

7. If interest or time is allowed, have students construct their projects.

8. Have students use their shop plans from Lesson 21 to arrange their shop into areas.

SUGGESTED EVALUATION:

1. Evaluate students' assigned class work.

2. Evaluate students' shopwork.

UNIT VI

ANIMAL SCIENCE

Introduction to the Unit

The Animal Science Unit is structured to provide information for the student in the baisc concepts of the production industry. The student is provided information on techniques in livestock selection and management guidelines for different livestock species.

LESSONS:

1. Economics of Livestock
2. Livestock Breeds
3. Choosing the Livestock Enterprise
4. Selecting Breeding Stock
5. Selection of Meat Type Animals
6. Dairy Cattle Selection
7. Horse Selection
8. Poultry Selection and Egg Grading
9. Animal Reproduction
10. Animal Digestion
11. Feed Nutrients
12. Feeding Livestock
13. Livestock Disease Prevention
14. Livestock Management Practices
15. Fitting and Showing

OBJECTIVES:

Upon completion of the unit the student will be able to:

1. Describe the effects the livestock industry has on the state, nation, and world.

2. Select the type of livestock enterprise suited for given farming conditions.
3. Select breeding and feeding stock and poultry from both visual observations and records.
4. Evaluate fattened livestock to determine the most desirable type.
5. Grade eggs to government specifications.
6. Describe the basic physiology and methodology of animal reproduction.
7. Describe the digestive systems of ruminants and simple-stomached animals, and why feed requirements differ for livestock species.
8. List the basic nutrients, functions of each, and feed sources for each.
9. Balance a ration for percent of protein.
10. Practice proper management in feeding livestock.
11. Develop health programs for selected livestock operations.
12. Demonstrate basic livestock management skills.
13. Prepare livestock for show ring competition.

MOTIVATION:

Ask the class what would happen if everybody decided only to eat vegetables or plants. What problems would exist? Point out that there is a lot of land unsuitable to crops and that a large amount of grain produced can only be fed to livestock. Some grains with lower quality protein can be converted to a high quality protein by feeding to animals.

TEACHING REFERENCES:

A. General References:

1. The Science of Animal Husbandry, Reston Publishing Company
2. Livestock and Poultry Production, Prentice-Hall, Inc.
3. Beef Production, Prentice-Hall, Inc.
4. Dairy Production, Prentice-Hall, Inc.
5. Swine Production, Prentice-Hall, Inc.

6. Livestock Judging and Evaluation, Purdue University AS-388
7. The Horse, W. H. Freeman and Company
8. 4-H Horse Judging Manual, Purdue University
9. Dairy Cattle Judging Techniques, Prentice-Hall, Inc.
10. How to Judge Poultry and Eggs, Purdue University P-95
11. Sample Questions for 4-H and FFA Poultry and Egg Judging Contests, Purdue University, P-62
12. Reproduction Organs of the Boar and Sow, Purdue University, AS-320
13. Feeds and Feeding, Cullison, Reston Publishing Company

B. Addresses of Reference Materials:

1. Reston Publishing Company, Inc.
   Reston, Virginia 22090

2. Prentice-Hall, Inc.
   Englewood Cliffs, New Jersey

3. W. H. Freeman and Company, 660 Market Street
   San Francisco, California 94104

4. Mailing Room
   Agricultural Administration Building
   Purdue University
   West Lafayette, Indiana 47907

   OR County Cooperative Extension Service Office

C. Other Source Materials:

1. Animal Science Core Curriculum
   Instructional Materials Laboratory
   10 Industrial Education Building
   University of Missouri
   Columbia, Missouri 65201

2. Animal Science I, II, III, IV
   Vocational Instructional Services
   Texas A & M University
   College Station, Texas 77843

D. Handouts:

1. "Beef Performance Testing - Questions and Answers", Purdue University AS-331
2. "Indiana Sheep Performance Testing Program",Purdue University AS-269
3. "Indiana Swine Sire Progeny Testing Program," Purdue University AS-315
4. "Indiana On-Farm Boar Testing Program Rules and Regulations," Purdue University AS-38
5. "Indiana Station Boar Testing Program," Purdue University AS-399
6. "Hoosier Gold Medal Lamb Club and Regulations", Purdue University AS-57
7. "ISPTP - Flock Performance Data," Purdue University
8. "Which Steer Do You Think is Best?"
9. "How to Judge Poultry and Eggs, Purdue University P-95
10. "Sample Questions for 4-H and FFA Poultry and Egg Judging Contests," Purdue University P-62
11. "Reproduction Organs of the Boar and Sow," Purdue University AS-320
12. "Health Programming in the Beef Cow Herd," Purdue University VY-47
13. "Dairy Herd Health Programming," Purdue University VY-35
14. "Programming for Poultry Vaccines," Purdue University VY-42

E. Transparency Masters

1. "Parts of a Beef Animal"
2. "Parts of a Hog"
3. "Wholesale Cuts of Beef"
4. "Wholesale Cuts of Pork"
5. "Ideal Beef Conformation"
6. "Ideal Swine Conformation"
7. "Comparison of Correct with Defective Front Legs"
8. "Comparison of Correct with Defective Hind Legs"
9. "Substance of Bone and Set of Legs and Feet"

10. "Comparison of Live Steers (side view)"
11. "Comparison of Steer Carcasses (side view)"
12. "Comparison of Live Steers (front view)"
13. "Cross Section of Steer Carcasses (front view)"
14. "Comparison of Live Steers (rear view)"
15. "Cross Section of Steer Carcasses (rear view)"
16. "Dairy Cow Unified Score Card"
17. "Dairy Character"
18. "Body Capacity"
19. "Mammary Development"
20. "Dairy Herd Improvement Records"
21. "Conversion Factors"
22. "Dairy Cattle Pedigree"
23. "Parts of the Horse"
24. "Correct Balance in Conformation"
25. "Ideal Stock Horse Conformation"
26. "Common Conformation Defects"
27. "Parts of a Chicken"
28. "Factors to Consider in Selecting Pullets"
29. "Pullet Conformation"
30. "Factors to Consider in Selecting Flock Replacements"
31. "Layer Conformation"
32. "Evaluating Hens for Rate of Egg Production Past and Present"
33. "Broiler Conformation"
34. "Male Reproductive System"
35. "Female Reproductive System"
36. "Fertilization in Cattle"
37. "Puberty Age for Farm Animals"

38. "Recommended Breeding Ages for Livestock"

39. "Reproductive Cycle of Livestock"

40. "Mating Guide for Beef Cattle"

41. "Mating Guide for Swine"

42. "Digestive System of the Cow"

43. "Digestive System of Swine"

44. "Digestive System of the Chicken"

45. "Carbohydrates"

46. "Essentials of a Good Ration"

47. "Essential and Non-Essential Amino Acids for Swine"

48. "Using the Square to Figure Rations"

49. "Using the Square to Figure a Complete Ration"

50. "Average Temperatures of Livestock"

51. "Common Sanitary Conditions"

52. "Livestock Restraints"

53. "Restraints that Prevent Kicking"

54. "Casting and Restraining Methods"

55. "Restraining Sheep"

56. "Methods of Restraining Swine"

57. "Restraints of Horses"

LESSON 1: ECONOMICS OF LIVESTOCK

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write a brief paragraph stating the history of the livestock industry and how it has affected the economy.
2. List the jobs that are associated with the livestock industry.
3. Discuss the uses and values of livestock.
4. Describe the basic trends in population of classes of livestock in Indiana.
5. Describe in writing how Indiana, the United States, and the world is affected by the livestock industry.

MOTIVATION:

Ask the class: Who likes steaks? How about pork chops? How many had turkey last Thanksgiving? What do these products have in common? Lead discussion on how important livestock is to our everyday lives.

REFERENCES:

The Science of Animal Husbandry (Chapter I), Reston Publishing Company

Livestock and Poultry Production, Prentice Hall, Inc.

Beef Production (Chapter I), Prentice Hall, Inc.

Dairy Production (Chapter I-2), Prentice Hall, Inc.

Swine Production (Chapter I), Prentice Hall, Inc.

OUTLINE:

A. Importance of the Livestock Industry in History:
    1. The beginning:
        a. Man in New Stone Age began domestication of animals
        b. Early mountain man probably domesticated cattle, sheep, horses, goats, and dogs

   c. Early plains farmer probably domesticated cats, pigs, and poultry.
   d. Egyptian, Rome, Canaan, and African people worshipped and used cattle.
   e. Swine are mentioned in writings by Chinese historians in 4900 B.C.
   f. Sheep were one of the earliest domesticated species.

2. Animals brought to North America:

   a. Brought by Columbus on his second voyage.
   b. Spanish explorers brought in many animals - particularly horses.
   c. Early English settlers brought livestock with them.

3. Animal Industry growth in the U.S.

   a. Cattle marketed in the east for tallow and hides before the Civil War - Longhorn cattle in southwest.
   b. Civil War divided the market and made beef cheap in the south and expensive in the north.
   c. Demand for wool increased in both north and south during Civil War.
   d. After Civil War the trail drive from ranges to railroads was begun and caused the increased use of horses in the west.
   e. Pork was popular because of its curing qualities and much of it was produced from the east and spread westward as new land was opened up for grain production.
   f. Central terminal markets developed in the populated parts of the country.
   g. Refrigeration enabled terminal markets to move closer to the production areas.

4. Present situation:

   a. 56% of land is not tillable
   b. Meat is the primary food source in most countries--particularly in the United States
   c. With the rising standard of living in the United States, beef consumption has increased.
   d. Livestock production leads agricultural income in the United States
   e. Marketing is becoming decentralized with packers going to the producers' area
   f. 70% of annual corn production is consumed by livestock and poultry.

B. Jobs Associated with Livestock Industry

1. Farmer or rancher - production of livestock.

2. Farm or ranch hand - assists in the production of livestock.

3. Farm or ranch foreman - responsible for the daily operation of a farm or ranch

4. Feedlot manager - feeds cattle for market.

5. Feedlot employee - works in a department of the feedlot system (example: bookkeeper or receiver).

6. Auctioneer - sells livestock at markets.

7. Artificial inseminator - artificially breeds livestock (may be employed by a breeder association)

8. Feed store manager - supplies feed, and other equipment and supplies to producers.

9. Feed store employee - operates some phase of the feed store (example: mixes feed).

10. Feed mill operator - operates a feed mill for a feed lot or store.

11. Livestock buyer - buys cattle, buys hogs or sheep for farmers, feeders, or packing plants.

12. Commission man - sells livestock for the farmer or rancher.

13. Veterinarian - animal health.

14. Farm finance manager

15. Cooperative extension - supplies information

16. Vocational agribusiness instructors - works with community and trains students in livestock management.

C. Uses and Values of Livestock:

1. Conversion of low value feeds into higher value animal products:

   a. Hay
   b. Pasture
   c. Mill and packing house products
   d. Damaged grains, foods, garbage
   e. Grains

2. Control erosion by growing forages for livestock feed.

3. Returns nutrients to the soil by manure.

4. Diversification of production:

   a. Improve distribution of labor
   b. Distributes the risk

5. Animal products provide essential food nutrients.

6. Animal products provide clothing material.

7. In the past and still in developing countries animals are used for power.

8. Recreation is provided in many ways by animals.

D. Livestock Trends in Indiana:

Class of Livestock	Numbers in 1969	Numbers in 1974
Beef Cows	433,884	617,000 (1976)
Milk Cows	227,048	202,031
Swine (total)	4,440,389	3,293,997
Sheep (total)	283,037	155,583
Horses & Ponies	62,410	44,275
Hens & Pullets	11,328,748	13,436,729

E. Indiana Affected by the Livestock Industry:

1. Agriculture is Indiana's number one business.
2. In 1971 Indiana ranked 10th in the country in cash receipts from farm marketings:

Indiana's Rank in Production 1971

Class	Rank
All Cattle and Calves	21 (23) - 1976
Milk Cows	14
Beef Cows	27 (27) - 1976
Stock Sheep and Lambs	20
All Hogs	3
Chickens	7
Turkeys	20

F. The U. S. Effected by the Livestock Industry:

1. National markets reflect livestock supplies and demands.
2. The yearly crop yields used as livestock feeds reflect the market price of livestock.
3. Change in the average income reflects the eating habits and changes the demands on types of livestock.

G. World Outlook on Livestock Production:

1. Increasing world population.

2. The heavily populated developing countries are vegetarian.
3. As the average income of developing countries increases, more meat is consumed.

TEACHING LEARNING ACTIVITIES:

1. Ask the students which type of animal was probably first domesticated.
2. Discuss the basic history of domestic animals.
3. Have students research available references to find more about the history of livestock production in the United States. Discuss their findings in class.
4. Assign each student to list jobs associated directly with the livestock industry.
5. Discuss the jobs that students have listed and add other jobs left out.
6. Take a field trip to a livestock operation or show a film depicting some of the operations conducted in a livestock business.
7. Provide students with information on the livestock population and rankings for Indiana. Briefly review the figures.
8. Discuss with the class how the livestock industry influences or is influenced by Indiana, the United States, and the world.
9. Construct a bulletin board on the livestock industry theme with emphasis on supply and demand on the world market. Use the bulletin board during discussion.

SUGGESTED EVALUATION:

1. A written test covering class discussions.

LESSON 2: LIVESTOCK BREEDS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write letters to breed associations for information about particular livestock breeds.
2. Compile a list of livestock breeds giving their identifying characteristics.
3. Identify breeds of livestock from examples, pictures, and/or descriptions.
4. Describe why one breed may be better suited to a certain climate, area, or use.

MOTIVATION:

Give an example of two types of cattle, sheep, horses, etc. Divide the class into two groups and have each prepare an argument in support of their particular breed.

REFERENCES:

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice Hall, Inc.

The Horse, W. H. Freeman and Co.

OUTLINE:

A. Beef Breeds:

   1. Modern beef breeds are representative of two ancient types of cattle; Bos Taurus (Europeon breeds), and Bos Indicus (Asiatic breeds).
   2. Breeds can be divided into Standard Breeds, American Breeds, Crossbreeds, and Exotic Breeds.
   3. Beef Breeds:

BREED	ORIGIN	COLOR	HORN CHARACTERISTICS
Aberdeen Angus	Scotland	Black	Polled
Brahman	India	White to Dark Gray	Horned
Charolais	France	White to Cream	Horned

BREED	ORIGIN	COLOR	HORN CHARACTERISTICS
Devon	England	Red to Chestnut	Horned
Galloway	Scotland	Black	Polled
Hereford	England	Red-White face and underline	Horned
Red Angus	Scotland	Red	Polled
Red Poll	England	Red	Polled
Scotch Highland	Scotland	Silver, Golden, Light Red, Black	Horned
[1]Barzona	Arizona (USA)	Red	Horned
[2]Beefmaster	Texas (USA)	Red & White	Horned Some Polled
[3]Brangus	Oklahoma (USA)	Black	Polled
[4]Charbray	Texas (USA)	Golden to White	Horned
Polled Shorthorn	Ohio and Indiana (USA)	Red, White, Roan	Polled
[5]Red Brangus	Texas (USA)	Red	Polled
Polled Hereford	Iowa (USA)	Red, White faces and underline	Polled
[6]Santa Gertrudis	Texas (USA)	Red	Horned
Blond D'Aquitaine	France	Fawn to Light Red	Horned
Chianina	Italy	White	Horned
Gelbvieh	Austria & Bavaria	Tan-Yellow-Light Red	Horned
Hays Converter	Canada	Black, White	Both Horned and Polled
Limousin	France	Wheat	Horned
Lincoln Red	England	Red	Horned Many Polled
Maine-Aujou	France	Red & White to Roan	Horned
Marchigiana	Italy	Gray	Horned
Murray Grey	Australia	Silver Gray	Polled
Piedmont	Italy	Gray w/ Black on head neck, hooves and switch	Horned
Pinzgauer	Austria	Chestnut	Horned
Simmental	Switzerland	Red-White spots	Horned
Sussex	England	Red-White switch	Horned
Welsh Balck	England	Black-shaggy	Horned

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[1] Africander, Hereford, Angus, and Santa Gertrudis
[2] Hereford, Shorthorn, Brahman
[3] Angus, Brahman
[4] Charolais, Brahman
[5] Angus, Brahman
[6] Brahman, Shorthorn

B. Swine Breeds and Types:

1.

Breed	Origin	Special Characteristics
Berkshire	England	Black-white on feet and head, short snout, dished face
Chester White	Pennsylvania	White
Duroc	New York	Red
Hampshire	Kentucky	Black, white belt, erect ears
Hereford	Missouri	Some red & white as Hereford cattle
American Landrace	Denmark	White, extremely long bodied, large ears, cover most of the face
Poland China	Ohio	Black, six white points
Spot	Poland China Breeding	White, black spots
Tamworth	England	Red, long narrow head, erect ears
Yorkshire	England	White, erect ears

C. **Sheep Breeds:**

1. Fine wool breeds:

   a. American Merino. Originated in Spain and started in the U.S. in Vermont. White and usually horned. Non-seasonal breeder wool about the head.
   b. Debouillet. Originated in New Mexico from crosses of Rambouillet and Delaine Merino. Is white, horned, and adapted to sparse grazing conditions.
   c. Delaine Merino. Spanish Merino that has more meat characteristics than American Merino, is white and horned, and smooth bodied.
   d. Rambouillet. French origin. Is a white, horned breed, and a non-seasonal breeder. Most numerous breed in the United States.

2. Medium wool breeds:

   a. Cheviot. Originated in Scotland. Face and lower legs white and free of wool with a black nose and both males and females are polled.
   b. Dorset. English origin. White faced, can be horned or polled, non-seasonal breeder.
   c. Hampshire. English origin. Black, wooless ears and nose and polled.
   d. Montadale. Missouri origin from cross of 40% Cheviot and 60% Columbia. Characterized by bare face and bare legs below the knee.
   e. North Country Cheviot. Scotland origin. White and polled and similar to Cheviot.

f. Oxford. Originated in England. Polled very large and has wool about the face.
g. Shropshire, English origin. Both males and females are polled and the face is black, has some wool about face down to hooves.
h. Southdown. English origin. Similar to Shropshire, but has a gray colored nose, has wool on face.
i. Suffolk. English origin. Large body type, black bare face and legs. One of the leading meat-type breeds.
j. Cotswold. English. Polled and white, has long ropy wool falls over eyes.
k. Lincoln. English, polled, and white faced, wool on face. More popular in Australia and South America.
l. Romney. English. White, open faced with foretop above eyes and little to no wool below knees.

3. Crossbred wool breeds:

a. Columbia. Wyoming and Idaho origin. White, open faced, polled. Originated from Lincoln rams and Rambouillet ewes.
b. Correidale. From New Zealand. Polled head and white with open face. Originated from Lincoln rams and Merino ewes.
c. Panama. From Idaho. Characteristics similar to Columbia. Originated from Rambouillet rams and Lincoln ewes.
d. Targhee. From Idaho. White, polled and open faced. Originated from Rambouillet rams and Columbia ewes.

4. Carpet wool breeds: Scottish Blackface--both sexes horned, free from wool on legs and black or mottled colored.

5. Fur-Sheep breed: Karakul from Central Asia. Black or brown, only the rams are horned. Used for the production of lamb pelts.

6. Woolless breeds:

a. Black-bellied Barbados from Barbados Islands.
b. St. Croix - from St. Croix, France.
c. Wiltshire Horn - from England.
NOTE: Used for crossing in southern United States because of resistance to heat and parasites.

D. Dairy Breeds' Top Producers

Breed	Name	Test Days	lbs. milk	lbs. fat	Year
1. Jersey	Rocky Hill Debbie Rockal	305	28,150	1,418	1977
2. Guernsey	Maxrales F J Carol	305	29,040	1,054	1970
3. Holstein-Friesian	Beecher Arlinda Elen	305	50,314	1,572 (365 days)	1975

Breed	Name	Test Days	lbs. milk	lbs. fat	Year
4. Brown Swiss	Green Pasture's Rayetta	305	31,900	1,401	1977
5. Ayrshire	Leete Farms Betty's Ida	305	37,170	1,592	1977
6. Milking Shorthorn	Barrington A	305	23,900	801	1976
7. Dutch Belted	Loraine No. 3020	305	18,211	816	1969

E. Dairy Breed Characteristics:

1. Jersey

   a. origin - Island of Jersey - English Channel
   b. color - light fawn to black can have white spots, muzzle-black with light ring
   c. size - cows 800-1100 lbs, Bulls 1200-1600
   d. other - grazing ability - does well on low quality pastures.

2. Guernsey

   a. origin - Island of Guernsey - English Channel
   b. color - light fawn to almost red with white markings on face, legs, switch, and flank.
   c. size - cows 800-1300 lbs, bulls average 1700 lbs.
   d. other - not equal to Jersey on poor pasture or to a Holstein on good pasture

3. Holstein-Friesian

   a. origin - Holland
   b. color - black and white
   c. size - cows 1300-1600 lbs, bulls at least 1800 lbs to over 2000 lbs.
   d. other - large milk producers, with high maintenance feed requirements suited to best production from top quality pastures.

4. Brown Swiss

   a. origin - Switzerland
   b. color - light fawn to black - nose, tongue, switch, and horn tips black - the muzzle and a stripe along backbone is light in color.
   c. size - cows 1200 - 1400 lbs., bulls 1600-2400 lbs.
   d. other - rugged active grazers. Meatier type - used some for crossbreeding with beef cattle

5. Ayrshire

    a. origin - Scotland
    b. color - red and white
    c. size - cows average 1250 lbs, bulls 1600-2300 lbs
    d. other - rugged and can be nervous and very active. More numerous in the New England States.

6. Milking Shorthorn

    a. origin - Northeastern England
    b. color - red, white or roan
    c. size - cows 1400-1800 lbs, bulls 2,000 to 2400 lbs
    d. other - better adapted to good pasture than to poor pasture used for crossbreeding with beef breeds. Considered a dual purpose breed for milk and beef.

7. Dutch Belted

    a. origin - Holland
    b. color - black with white belts
    c. size - cows 900 to 1500 lbs, bulls average 2,000 lbs.
    d. other - imported to U.S. by P.T. Barnum. Similar in size and grazing ability to Holstein-Friesian

F. Horse Breeds:

1. American Saddle Horse:

    a. Foundation Sire - Denmark, foaled in 1839 with Arabian and Thoroughbred breeding
    b. Developed in Kentucky
    c. Breeds used in development - Thoroughbred, Standardbred, Arabian, and Morgan

    d. Two types; five gaited and three gaited:

        1) Five-gaited, shown with flowing mane and tail, executes walk, trot, canter, slow gait, and rack
        2) Three-gaited, shown witn clipped mane and tail, plucked for twelve inches from base, executes walk, trot, and canter

2. Arabian:

   a. Ancient breed descendent of Tarpan - wild horse of eastern Europe
   b. Oldest Arabians were noted to occur in Pershia 2,000 years B.C.
   c. Mohammed used the Arab for his armies in the 7th Century A.D. and from that time the Arabian horse has been pure-bred by the Bedouin tribes.
   d. Arabian horses are the foundation for many breeds.
   e. Famed for a kind disposition, hearing, and sense of direction and memory.
   f. The head is the most distinguishing characteristic of the breed. (A triangular shape.)
   g. Body is typically gray or dappled to white. Very few Arabs are black.
   h. Uses-three-gaited saddle, stock, pleasure

3. Appaloosa:

   a. Originated from Spanish imports
   b. Nez Perce tribes of the Palouse River country in central Idaho and eastern Washington captured the wild horses and developed the breed by keeping the spotted horses and using only the best stallions for breeding for over a hundred years.
   c. Recent years Quarter-Horse, Throughbred, and Arab breeding has been added for breed improvement
   d. Characteristics - parti-colored skin, and white sclera encircling the eye. Most have vertically striped hoofs and wispy mane and tails.
   e. Uses - three-gaited saddle, stock, pleasure.

4. American Albino:

   a. Color type breed - developed in 1937. Foundation Sire - Old King foaled 1906 may have been out of Arabian - Morgan breeding.
   b. A gentle disposition
   c. White color, dark eyed
   d. Uses - circuses, parades, pleasure.

5. Morgan:

   a. Foundation Sire - Justin Morgan - foaled 1789
   b. Ancestry - Thoroughbred, Arabian, Barb and some Draught Horse breeding
   c. Characteristics - Gray to brown, neck is well-crested, height is 14:1 to 15:2 hands
   d. Used as saddle, stock, pleasure and light harness. Older use as trotter in racing

6. Paint:

   a. Derived from Pinto breed, but contain only Quarter Horse or Thoroughbred blood.
   b. Paints foaled in 1964 or after. Must be sired by a horse registered in the American Paint Horse Association, American Quarter Horse Association, or the Jockey Club.
   c. Characteristics - color; Overo - white extending upward and irregular pattern, Tobiano - marked pattern with white as base and another color divided half and half through the coat
   d. Uses - stock, racing, pleasure

7. Palomino:

   a. Color breed - represented by Arab, Morgan, Saddlebred, Standardbred, Tennessee Walker, Throughbred, Quarter Horse, and Welsh
   b. Three types - stock type, (Quarter Horse and Morgan) Pleasure type (Walkers, Saddlebreds, and some Arabian), and the parade type (includes both of the other types).
   c. Color - color of mint condition gold coin, but three shades lighter or darker are allowed

8. Pinto:

   a. Color breed - represented by Saddlebred, Arab, Welsh, and Morgan
   b. Three types - Pleasure, stock, and racing types.
   c. Characteristics - Color: Overo and Tobiano.

9. Quarter Horse:

   a. First breed established in the United States and most numerous horse breed in the United States
   b. Foundation Sires - Arabs, Barbs, and Turks of Spanish origin and foundation mares from Florida and Texas Indian tribes gave rise to two types called choctaw and chickasaw.
   c. Later short, stockey English horses were added into the breeding giving the breed the compact, heavy muscled conformation
   d. Later Throughbred breeding was added
   e. Four types exist at present - Bulldog type (original colonial horse) Semi-Bulldog (Muscular with smoother lines), Progressive type (semi-bulldog and running types), Running type (Tall, more refined)

10. American Standardbred:

   a. Pacers and Trotters
   b. Foundation Sire - Hambletonian 10, foaled 1849
   c. Origins from Throughbreds from England
   d. Mares serviced by Hambletonian 10 were of Hackney, Morgan and Tennessee Walker blood
   e. 1879 a standard was set at two minutes, thirty seconds as a basis for registration
   f. Uses - racing

11. Tennessee Walking Horse:

    a. History of breed began 1700's
    b. Foundation stock mixtures of Saddlebred, Morgan, Standardbred and Thoroughbred
    c. Allen F-1 - selected as the single breed sire (Saddlebred and Morgan)
    d. Colors - all except Albino (Bay, black, sorrel and chestnut predominant) White markings are common
    e. Gaits, walk, running walk, canter
    f. Uses - pleasure and show ring, bird hunting field trails

12. Thoroughbred:

    a. Originated in England early 1700's
    b. Foundation sires were Arabians, Barbs, and Turks. Three Stallions recognized: The Byerly Turk, The Godolphin Arabian (Barb) and The Darley Arabian
    c. Thoroughbred blood has been used to improve other breeds and is in the foundations of many breeds
    d. Two types - 1) Taller, heavier built types used as jumpers and hunters, 2) Longer, lankier built used for racing
    e. Colors - Bay, black, chestnut, and gray (white markings common)

13. Hackney Pony:

    a. Originated in England as a coach horse
    b. Types - Harness ponies, 50 inches or less, Hackney ponies 50 to 58 inches, Hackney horses over 14.2 hands
    c. Uses - Harness show, pleasure, jumping
    d. Colors - Black, brown, bay, sorrel and chestnut

14. Pony of the America's:

    a. New breed dating to early 1950's
    b. Four breeds used - Quarter Horse, Arabian, Appaloosa, Welsh, and Shetland
    c. Characteristics - Show miniaturized Quarter Horse, Appaloosa, Arabian appearances Colored same as appaloosa.
    d. Uses - pleasure, racing, jumping

15. Shetland Pony:

    a. Originated on the Shetland Islands off the coast of Scotland
    b. Originals resembled small draft animals
    c. Types: Ordinary - stocky with some wooly hair and medium thick mane and tail; American type - Hackney blood added; Miniature type - 20-36", very wooly and used as pets or in teams to harness

16: Welsh Pony:

    a. Originated in North Wales
    b. Andalusian, Arab, Barb and Turk breeding was added to the original pony and later more Arab, Hackney, and Thoroughbred was added to the breeding
    c. Height varies from 10.2 to 14.2 hands

17. American Percheron:

    a. Colors - Black and gray
    b. Draught horse
    c. French originated

18. American Belgian:

    a. Sorrel or roan, white mane
    b. Draught horse
    c. Originated in Belgium

19. American Clydesdale:

    a. Colors - Bay, brown, black, gray with white on face and legs and sometimes on other parts of the body
    b. Draught horse
    c. Originated in England

G. Breed Associations for Horses:

1. The American Hackney Horse Society
527 Madison Avenue, Room 725
New York City, New York 10022

2. American Quarter Horse Association
P O Box 271
Amarillo, Texas 79105

3. American Saddle Horse Breeders Association
929 South Fourth Street
Louisville, Kentucky 40203

4. The American Shetland Pony Club, Inc.
P O Box 1250
Lafayette, Indiana 47902

5. Appaloosa Horse Club, Inc.
Box 403
Moscow, Idaho 83843

6. The Arabian Horse Club Registry of America
One Executive Park, 7801 East Belleview Avenue
Englewood, Colorado 80110

7. The Jockey Club
300 Park Avenue
New York City, New York 10022

8. The Morgan Horse Club, Inc.
P O.Box 2157
West Hartford, Connecticut 06117

9. Palomino Horse Breeders of American, Inc.
P O Box 249
Mineral Wells, Texas 76067

10. The Pinto Horse Association of America, Inc.
P O Box 2984
San Diego, California 92103

11. American Paint Horse Association
P O Box 12487
Fort Worth, Texas 76116

12. The Pony of America Club
Box 1447
Mason City, Iowa 50401

13. Tennessee Walking Horse Breeders' Association of America
P O Box 286
Lewisburg, Tennessee 37091

14. The Welsh Pony Society of America, Inc.
202 North Church Street
West Chester, Pennsylvania

15. Belgian Draft Horse Corporation of America
Wabash, Indiana

16. Clydesdale Breeders' Association of the United States
Batavia, Iowa

17. Percheron Horse Association of America
Fair Oaks, Indiana

18. Standard Jack and Jennet Registry of America
Lexington, Kentucky

H. Popular Breeds and Varieties of Poultry

Class	Breed	Variety
American	Plymouth Rock	Barred, White, Buff
	New Hampshire	
	Rhode Island Red	
	Wyandotte	
Mediterranean	Leghorn	Single Comb White, Rose Comb White, Single Comb Brown, Rose Comb Brown
English	Orpington	Buff, White
	Cornish	Dark, White
Asiatic	Brahma	Light, Dark
	Cochin	Buff, Partridge

TEACHING LEARNING ACTIVITIES:

1. Early, several months before this lesson is to be taught, have the students write to some of the different breed associations for information about breeds.

2. Give the students a pre-test to determine how much they know about the breeds of certain livestock species.

3. Have students make a bulletin board chart showing the different breeds.

4. Have each student complete a chart with information about the breeds of a certain type of livestock. They should include - origin, body characteristics, color or markings, and uses.

5. Have a contest in class on breed identification. Provide one side with one species and the other with a different species. Give side #1 a description and/or picture to identify-if missed ask the other side. There are several variations of this game. Have each person in the row identify the livestock seperately.

6. In later lessons on field trips ask the students the breeds that they are viewing.

7. Discuss how climate, area, or use can affect the characteristics of breeds (give examples).

SUGGESTED EVALUATION:

1. Provide a quiz on breed identification.

2. Assign grades to the breed charts.

LESSON 3: CHOOSING THE LIVESTOCK ENTERPRISE

OBJECTIVES:

At the completion of this unit the student should be able to:

1. List the factors that should be considered when selecting a livestock enterprise.
2. Write comparisons of management, land, labor, and capital requirements of various livestock enterprises.
3. List basic management skills necessary for success in a selected enterprise.
4. List the advantages and disadvantages of various enterprises.
5. Select a type of livestock for a given type of farming situation.

MOTIVATION:

If I were to give you just two acres, what kind of livestock enterprise would you put on it? What livestock enterprise would return the most profit? What type would require the most labor? At this point the students should realize there are many variables to be considered.

REFERENCES:

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice Hall, Inc.

Beef Production, Prentice Hall, Inc.

Dairy Production, Prentice Hall, Inc.

Swine Production, Prentice Hall, Inc.

OUTLINE:

A. Factors to Consider When Selecting Livestock Enterprises:

   1. Amounts of grain and forage crops produced in the cropping system.
   2. Regularity and stability of net income required.
   3. Amount of labor available.

4. Distribution of labor requirements for livestock during the year as compared to the crop labor requirements.

5. Skill and personal likes of the manager.

6. Available markets.

7. Capital requirements and rapidity of capital turnover.

8. Profit required.

B. Characteristics of Individual Livestock Enterprises:

1. Beef cow herd:

   a. Low rate of return on feed.
   b. Low return (slow turnover) on capital, high investment.
   c. For profit, feed costs must be kept down and a calf crop close to 90% is essential.
   d. Labor requirements are low.
   e. Housing and equipment requirements are low.
   f. Difficult to have cows calve near same time and not spread calving throughout the year.
   g. Calves may be sold off cows in the fall or fed out. Feeding out the calves will furnish a better market for high quality roughage than the beef cows.
   h. Heavy culling is essential.
   i. Small herds, a supplemental type of enterprise, will utilize feed that might otherwise go to waste or have little market value.
   j. Large herds fit the farms that produce large quantities of low quality forage and have a limited supply of labor.

2. Feeder cattle:

   a. Low returns on feed.
   b. Low labor requirements to market a given quantity of feed.
   c. High capital requirement.
   d. Wider fluctuations in returns from year to year than most other livestock enterprises.
   e. Skill in buying and selling is of utmost importance.
   f. Low capital requirements in housing and equipment.
   g. Margin, or the spread between purchase price and selling price, usually necessary to make enterprise profitable.
   h. Time of marketing, grade and weight desired, determine method of feeding.
   i. Risks can be reduced by planning enterprise on basis of normal seasonal trends.

3. Hogs:

   a. High rate of return on feed.
   b. Short time required to obtain turnover on capital. (6 months)

c. Low capital requirements compared to other kinds of livestock.
d. High labor returns.
e. Very responsive to high level skill and management.
f. Permit a wide range of systems (one, two, multiple litter systems; early or late farrowing; confinement or pasture).

4. Sheep (farm flock):

a. Low capital requirement.
b. Low cost housing requirements.
c. Low labor requirements - but certain skills and knowledge are mandatory.
d. Parasite control necessary for successful enterprise.
e. Lamb crop of one and one-half lambs per ewe is a reasonable goal.
f. Value of lamb crop is greater than value of the wool.
g. Well-bred meat-type rams should be used, either on western or native ewes.

5. Lamb feeding:

a. High risk enterprise because:
   1) Normally price spread is not adequate for profit
   2) High death loss is not uncommon
   3) Lambs are sensitive to off-grade feeds
b. Offer quick turnover on capital.
c. Skilled lamb feeders often find the enterprise very profitable.
d. Margin price is the important source of profit.
e. High degree of marketing skill is necessary.

6. Dairy:

a. One of the most profitable methods of marketing forages that are necessary for good crop rotation.
b. Size of enterprise is determined by:
   1) Amount of hay and pasture produced on the farm
   2) The competition for labor and capital on the farm
   3) Housing facilities available
   4) Market outlet for dairy products
c. Comparatively high returns for feed.
d. Comparatively low returns for labor.
e. Level of dairy production generally determined by whether the enterprise is a major or a minor one.
f. If a major enterprise, the substitution of capital for labor and the application of work simplification is of major importance.
g. Level of grain feeding determined by price of product, cost of grain, quality of roughage, production ability of the cow, and alternative opportunities of using the same resources more profitable in other enterprises in the farm business.
h. Guaranteed sale price of product (support price).

7. Poultry:

    a. High return on feed.
    b. Labor requirements are high and the enterprise generally gives a low return on labor.
    c. Capital requirements are medium to low and give a relatively fast turnover.
    d. Offers an opportunity to use labor and management of the wife and children on the farm.
    e. Very responsive to above average management.
    f. Intensification of practices determined by size of enterprise and alternative use of labor, capital, feed, equipment, and managerial skill.
    g. Production and marketing basis for a successful enterprise.

(From Farm Management Background Material, FM 1177, Iowa State University Cooperative Extension Service, Ames, Iowa, 1954)

C. Management Skills:

1. Record keeping.

2. Health and sanitation procedures.

3. Observation and inspection of livestock.

4. Balancing and regulating feed rations.

5. Management and maintenance of facilities and equipment.

6. Scheduling births and animal number increases and decreases with available facilities and annual market fluctuations.

7. Buying and selling livestock.

8. Other specialized skills in each enterprise.

D. Advantages and Disadvantages of Enterprises (refer to characteristics of each livestock enterprise),

E. Livestock for a Particular Farming Situation (examples):

1. Large acreage of permanent pasture - cow, calf or sheep enterprise.

2. Farm with 2/3 of acreage in grain crops - swine production or feed lot for swine or cattle or use crop land for silage production for dairy or beef cattle.

TEACHING LEARNING ACTIVITIES:

1. Have students that have a livestock enterprise at home explain why their enterprise works for them.

2. Ask students to list factors that would influence the type of livestock enterprise that would be selected. Write the students' ideas on the chalkboard during discussion.

3. List the major livestock enterprises on the chalkboard. Have students discuss what some of the characteristics are for each enterprise.

4. After compiling a list of the characteristics of the different enterprises ask the class to discuss which enterprise is a reasonably safe investment. Assume that the managerial skills are high.

5. Divide students into groups and provide them with a sample farm. Ask each group to determine a livestock enterprise for their sample farms.

SUGGESTED EVALUATION:

1. Quiz students on discussion material.

2. Assign grades to group decisions on sample farm problem.

LESSON 4: SELECTING BREEDING STOCK

OBJECTIVES:

The Student should be able to:

1. List seven factors which you would consider when selecting breeding stock.
2. List important physical elements of livestock selection which are common to all classes.
3. Review with the class how to age sheep by teeth. Ask students why it is important to check the teeth when selecting breeding stock.
4. Write an explanation of why the show ring is an important part of livestock selection.
5. Describe in writing how pedigree plays a part in breeding stock selection.
6. List the livestock improvement agencies and explain how they operate.
7. Fill out progeny and performance records to be used in selection.

MOTIVATION:

1. Ask students if they have ever watched a class of heifers, bulls, ewes, rams or gilts or boars being judged. Why the concern over the selection of breeding stock? What's the difference - just as long as they reproduce isn't that really all that's important?
2. What traits might a college basketball coach look for in potential players? Why? Are these traits important to a player's function? Can you see why guidelines are important in making selections of either livestock or basketball players?

REFERENCES:

Livestock Judging and Evaluation, Purdue University

The Sheepman's Production Handbook, Sheep Industry Development Program

Handouts: "Beef Performance Testing - Questions and Answers", Purdue AS 331
"Indiana Sheep Performance Testing Program", Purdue AS 269
"Indiana Swine Sire Progeny Testing Program", Purdue AS 315
"Indiana On-Farm Boar Testing Program Rules and Regulations", AS 38
"Indiana Station Boar Testing Program", Purdue AS 399
"Hoosier Gold Metal Lamb Club and Regulations", Purdue University
"ISPTP - Flock Performance Data", Purdue University

OUTLINE:

A. Selection Factors:

1. Physical appearance or form.
2. Health
3. Uniformity
4. Fertility
5. Mothering ability
6. Price
7. Registered, purebred, grade, crossbred
8. Breed performance
9. Previous performance of sire and dam
10. Performance of brothers and sisters
11. Performance of Progeny

B. Physical Appearance - Look For:

1. Soundness on feet and legs. Freedom of movement.
2. Evidence of masculinity or femininity.
    a. Masculinity:
        1) Ruggedness
        2) (at maturity) Masculinity about the head
        3) Evidence of fully developed testicles
    b. Femininity:
        1) Fully developed reproductive tract
        2) Proper teat size and placement
        3) Adequate bone
        4) Broody head and neck
3. A high volume of long smooth muscles.
4. Capacity: wide chest, sufficient spring of rib. Capacity enables animals to gain rapidly and utilize feed and insures room for fetal growth of large, vigorous offspring.
5. Conformation: How suitable is the animal's form in reference to his or her desired function:
    a. Meat animals - should appear to have large volume of desirable muscling and free from waste, and adequate frame to reach desired market weight.

b. Dairy - cows need to have high capacity, and should show angularity in the head, shoulder, neck, and rump areas.

c. Egg layers - streamlined for egg production.

C. Determining Age from Teeth in Sheep

1. New born - no teeth
2. Three month old - temporary incisors present (8)
3. Twelve to fifteen months - temporary pinchers replaced by two permanent pinchers.
4. Two years - first temporaries replaced by permanent teeth.
5. Three years - second temporaries replaced.
6. Four years - temporary corner incisors replaced by permanent teeth "full month".
7. After four years impossible to tell exact age - wearing of teeth is the only indicator.
8. Important in breeding stock to check that sheep have all of their teeth. Rub fingers across teeth will give a quick check when judging.

D. Sheep Jaw Configuration:

1. Undershot jaw (parrot mouth).
2. Overshot jaw (monkey mouth).
3. Normal mouth.

NOTE: 1 and 2 are considered disqualifications in sheep and may be more important than determining age in sheep judging.

E. Show Ring Performance - Serves as a pattern for the entire industry. A showcase for a breed or species.

F. Pedigree - Should be used as a means of selection after past performance and appearance have been taken into consideration.

G. Livestock Improvement Agencies

1. DHIA - Dairy Herd Improvement Association.
2. ISPTP - Indiana Sheep Performance Testing Program.
3. National Pork Producers Council.
4. Performance Tested Beef - Cooperative Extension Service
5. Breed Agencies.

TEACHING LEARNING ACTIVITIES:

1. Ask the students what factors should be considered when selecting livestock? List their answers on the chalkboard and add additional factors and discuss each of the factors.

2. Ask how each of these factors can be determined:

   a. Visual evaluation
   b. Production records

3. Discuss the visual observations that should be made and explain why specific importance is placed on different parts when considering breeding stock compared to market animals.

4. Great Colossal Blue Ribbon Champion's Pride III just won first place at your county fair. Would you buy him? What questions would you want answered before deciding what he was worth? How do fairs contribute to the improvement of livestock? What value is show ring performance in selecting breeding stock? Discuss the importance and point out that there are other methods of selection to add to visual observations.

5. Show the class the pedigree of an animal. Ask how pedigrees can be used as a means of selection?

6. Can we make a selection for breeding stock by a visual judgment or is more information needed? How is production of animals sold as breeding stock evaluated? Review the different organizations that aid in performance testing.

7. Have a representative of a breed organization, DHIA, or Cooperative Extension Livestock Specialist talk to the class about production records and how they are an important means of selection.

8. Briefly review and discuss the handouts on how performance testing is conducted.

9. Divide the class into groups and hand each group the records of four or five animals. Allow each group to categorize each animal from top selected choice to bottom selected choice and prepare a report on why one animal would be selected over another. Have each member of group give a part of the report. The records could be obtained from testing stations, local breeders, or breed catalogs.

SUGGESTED EVALUATION:

1. Quiz students on information discussion in lessons.

2. Evaluate the group activity.

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Beef Performance Testing -- Questions and Answers

L. A. Nelson, K. G. MacDonald and K. J. Drewry, Animal Sciences Department

Performance testing of beef cattle has been gaining acceptance the past two decades and is now considered an integral part of beef cattle management. Many states, including Indiana, offer performance testing programs through their Cooperative Extension Services, and most national breed associations also conduct testing programs. This publication attempts to answer some of the more frequently asked questions about performance testing of beef cattle.

What is performance testing? It is a simple, accurate method of obtaining systematic records on the production of each animal in the herd. Performance testing offers beef cattle producers a means of measuring differences among animals in heritable traits.

Who should performance test? Any beef producer, purebred or commercial, should consider performance testing to help evaluate his herd.

Why performance test? Performance testing provides a basis for comparing cattle handled alike within a herd. Differences among animals in traits of economic value are heritable to a large degree. Thus, systematic measurement and use of records in selection will lead to genetic improvement within herds and breeds of cattle, increasing profits.

What traits are considered? Those traits that contribute both to productive efficiency and desirability of product should be measured. Regular reproduction, rapid growth, efficient feed conversion, and carcasses preferred by packers and consumers are traits of major economic importance. Most programs provide for measuring and recording calving record, birth weight, weaning weight and grade, yearling weight and grade, and carcass information.

How can performance test records be used? Use beef performance records to increase profits in the following ways:

1. Determine and improve percent calf crop.
2. Increase weaning and yearling weights.
3. Improve conformation grade of calves and yearlings.
4. Cull low-producing cows.
5. Aid in selection of replacement heifers and herd bulls.
6. Evaluate each sire within the herd.
7. Improve overall herd management.
8. Provide additional information to potential buyers.
9. Help advertise the merits of the herd.

Does Purdue offer a performance testing program to beef cattle producers? Yes, the Indiana Beef Performance Testing Program is available to all producers in the state and is administered by the Indiana Cooperative Extension Service at Purdue University. Weights and other data are recorded

Beef Section • Animal Sciences Department

Cooperative Extension Service, PURDUE UNIVERSITY, Lafayette, Indiana

on the producer's farm, and performance records are processed and summarized by computers.

What are the performance test requirements of the Indiana Beef Performance Testing Program? The requirements are as follows:

1. Permanently identify each cow and calf.
2. Record number, birth date, sex, dam and, if possible, the sire of each calf.
3. Weigh all calves between 160 and 250 days of age, preferably between 180 and 230 days.
4. In purebred herds, record yearling weights and grades between 330 and 450 days of age.
5. It is recommended that carcass information be obtained on at least 8 steers from each sire.

Should I wait until I have culled some cows and have my herd built up before testing? Definitely not! Start performance testing now so that you will have some records on which to base your decision to cull cows or select replacement heifers. Culling cows on their looks alone is often a mistake, since some of the poorest-looking cows may actually wean the heaviest calves.

How should cows and calves be identified? Any permanent numbering system is acceptable. Animals should be visibly identified to prevent loss of time in reading tattoos when cow or calves are weighed. For cows, hot or freeze brands can be used, but neck chains or flexible, plastic ear tags are also good methods of identification if combined with a tattoo number. For the calves, it is best to tattoo each one and also use an ear tag for easy identification. Flexible, plastic ear tags have been used with much success.

How much time is required to performance test a herd? Time required depends primarily on the kind of handling facilities available. Simple, workable corrals and chutes can be built easily with rough lumber. Plans are available at your local County Extension Office. Very little time is needed to fill out data forms.

Do I need a scale? Yes, each producer has the responsibility of providing scales, either his own or borrowed. Many county or area groups have purchased portable scales, thereby reducing the cost per producer. Scales are essential to everyone in the business of producing beef.

Is it necessary to weigh calves at birth? No, but recording birth weight is encouraged to relate this information to calving ease, growth rate, etc. If calves are not weighed at birth, a "standard" of 70 pounds is used for all calves as recommended by the Beef Improvement Federation.

Who does the weighing and grading of calves? A breeder may do his own weighing and grading with the help of local cattlemen, or he can request assistance from Cooperative Extension Service personnel in evaluating his cattle. Groups of producers in a county are encouraged to exchange grading duties, especially at weaning. Extension personnel can be of greater assistance by helping place meaningful yearling grades on cattle.

How should bulls be gain tested? Wean and weigh bull calves at 6 to 8 months of age. Then feed a moderate energy ration (60-70% TDN) for at least 140 days to bring out genetic differences in gainability. A recommended ration is a full-feed of corn silage, plus 1% of bodyweight of corn and 2 pounds of Purdue Supplement A per head daily. Feed all bulls the same ration for the same length of time in order to validly compare their gain on test.

Should bulls be tested at home or in a central station? Either method is acceptable, but the cost of testing at home is much less than at a test station. A central testing station can supplement, but not replace, on-farm testing. Central tests have limited value in estimating genetic differences between herds, but are most useful to small breeders who do not have the facilities to test bulls at home. Preferably, bulls should be accepted for central testing only if the breeder is actively participating in an on-farm performance testing program, and if his bulls meet rigid requirements for weight per day of age, soundness and health.

If weights increase, will quality go down? No. Improvement in weaning or yearling weights and grade should go hand in hand if both are considered in the selection program. Weight is more highly heritable than is conformation grade, i.e., differences among animals in yearling weight are due more to genetics than to environment. On the other hand, conformation grade, especially at weaning, is largely the result of environmental differences.

What is meant by adjusted weight? It is the weight of a calf standardized for differences which are not heritable, such as age at weighing, age of dam and sex of calf. Actual weaning weights are adjusted to estimate what a calf (steer basis) would have weighed at 205 days of age if its dam had been mature (5-10 years of age). Yearling weights are adjusted to 365 days of age by combining the adjusted 205-day weight (no sex correction) and postweaning average daily gain.

Are adjustments made for creep feeding? No, records are not adjusted for creep feeding per se, because no two producers have the same creep-feeding program. It would be impossible to make a "standardized correction" for type and amount of creep feed. All calves should be handled alike within a herd in order to make more accurate comparisons of their performance. If some calves are creep-fed and others are not, those performance records should be handled as two different groups and summarized separately.

What is the weight ratio? It is a term used to indicate the superiority or inferiority in weight of an individual relative to the average weight of all animals within that group. Weight ratio is calculated as:

$$\frac{\text{Individual's weight}}{\text{Average weight among group}} \times 100$$

It is useful for quickly determining the relative ranking of individuals within a group, because any animal with a weight ratio above 100 is heavier than the group average. Likewise, animals with weight below the average have weight ratios less than 100.

How can one compare calves born in two different seasons? Records from calves born within a 2- or 3-month period should be summarized together because seasonal and management differences will influence calf weights. Spring calves commonly outweigh fall calves by 25 pounds or more at the same age. Thus, animals born in different seasons can be compared more accurately on the basis of their weight ratios than their actual or adjusted weights.

Should performance records be used to compare different herds? No, the information is designed for use within your own herd. Most differences in performance between herds are environmental, i.e., due to nutrition and management. Therefore, comparisons of animals from two different herds should be based on weight ratios rather than actual or adjusted weights.

Are my testing records confidential? Yes! Each herd in the Indiana Beef Performance Testing Program is assigned a code number. All records are processed and filed according to your herd code. Herd averages and other performance data are not made public, unless you request that information from your herd be made available to someone.

Can performance testing records be used to help advertise your herd? Yes! But performance data used in ads or sale catalogs should be brief, pertinent, current, complete and authentic. Use 205-day and 365-day weights and ratios, plus carcass quality and cutability data. Avoid using misleading or non-standardized data such as: "this calfweighed 363 lbs. at 131 days of age" or "a son of this bull weighed 1,220 lbs. at 14-1/2 months."

Are performance testing programs always successful? No! The program is only as successful as the man using it. The integrity of the producer, the accuracy of the data and the proper use of the information are keys to the success of any performance testing program.

Am I going to performance test? That depends on you and your interest in the business of beef cattle production. Over 200 producers currently participate in the Indiana Beef Performance Testing Program. We encourage purebred breeders to also be enrolled in their own breed association programs.

How do I enroll in the Indiana Beef Performance Testing Program? Obtain information and data forms from your local County Extension Office or Extension Area Livestock Agent.

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Indiana Sheep Performance Testing Program

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Performance testing is recognized as an integral part of sheep production and a good management tool. Several states offer performance testing programs through their Cooperative Extension Services, and several national sheep breed associations currently offer testing programs. The purpose of this publication is to answer some of the more frequently asked questions about Indiana's Sheep Performance Testing Program.

Who can use the program? Any Indiana sheep producer — purebred or commercial — can utilize this performance testing program to help evaluate all sheep in his flock.

Who administers the program? The program is administered by the Indiana Cooperative Extension Service. Weights and other data are recorded and certified by the cooperator. Records are processed and summarized through Animal Sciences Extension-Sheep Section, Purdue University.

What is performance test? Performance testing is a simple, accurate method of obtaining systematic records on the production of each animal in the flock. Performance testing offers sheep producers a means of measuring differences among animals in heritable traits.

Why performance testing? Performance testing provides a basis of adjusting production records for known environmental factors and comparing sheep managed alike within a flock. Differences among the adjusted records of animals, in traits of economic value, are heritable to a large degree. Thus, the selection of flock replacements on basis of adjusted production records will lead to genetic improvement within flocks and breeds of sheep.

What traits should be measured? Economic traits that contribute both to production efficiency and desirability of product should be measured. These traits include: reproductive performance, growth rate, efficiency of feed conversion, and carcass traits that are indicative of quality and quantity (cutability) of meat produced.

The Indiana Flock Performance Program provides for measurement of ewe lambing record (singles, twins, etc.), lamb 90-day weight, lamb 210-day weight, and the optional measurement of ewe wool weight.

The Indiana Carcass Evaluation Program provides for measurement of carcass weight, carcass grade, loin fat cover, leg conformation grade, kidney fat, cutability and yield grade, and the optional measurement of loin eye area.

How can performance testing records be used? Performance records obtained and summarized through the Indiana Sheep Performance Testing Program can be used to:

1. Cull low-producing ewes.
2. Evaluate each sire within the flock.
3. Increase lamb crop percentage.
4. Increase 90- and 210-day lamb weights.
5. Improve overall flock management.
6. Aid in selection of replacement rams and ewes.
7. Provide additional production and carcass information for potential buyers.
8. Help advertise the merit of the flock.
9. Determine eligibility for participation in the Hoosier Gold Medal Lamb Club.

What must I do to performance test? Here are the steps to follow to participate in the Indiana Sheep Performance Testing Program:

1. Permanently identify each ram, ewe and lamb in the flock. Any permanent numbering system is acceptable. Animals should be visibly identified to prevent loss of time when weighing. No two animals in the flock, over time, should be given the same identification number. Do not give twins and triplets the same identification number.

2. Obtain Indiana Sheep Performance Testing Program data forms ISPTP-1, "Flock Performance Data," and ISPTP-2, "Carcass Data," from your local country Extension office, area Extension sheep agent or state Extension sheep specialist.

3. Record lamb, ewe and ram information on forms ISPTP-1 and ISPTP-2 including: lamb number; ewe data — number, class, breed, age (to nearest year at lambing) and wool weight (optional); ram data — number, class and breed; lamb birth data — birth code and birth data (month, day and year; e.g., February 27, 1974 would be recorded as 02-27-74).

4. Obtain 90-day weight on all lambs between 70 and 110 days. Complete the 90-Day Records (white sheet of form ISPTP-1) giving sex, rearing code and date and weight. If the lamb was reared by a foster ewe, list her number in the "foster ewe" column. If the lamb was bottle- or hand-fed, enter HAND in the "foster ewe" column. Use "coded remarks" column as needed (see Table 1). When 90-day weight has been obtained on all lambs, complete owner information (name, address and type of flock), certify the records by signing, and forward the 90-day records (white sheet) to address given in upper left of the form for summarization.

5. Obtain 210-day weight, between 180 and 240 days, on all replacement and sale lambs previously weighed at 90-days. Complete the 210-Day Records (yellow sheet of ISPTP-1) giving sex, date and weight, and forward for summarization.

6. The suggested weigh schedules presented in Tables 2 and 3 will assist in determining the time to weigh lambs for 90- and 210-day weights.

7. Obtain carcass data on at least eight wether progeny of each sire. Complete one ISPTP-2 for each wether, and forward both white and yellow sheets for summarization.

When should I start performance testing? Now! Performance test records will assist you in culling ewes, selecting replacements and selling ewes and rams. Culling ewes on their looks alone is often a mistake, since of the poorest-looking ewes may actually produce the heaviest lambs at 90 days and the best performing lambs at 210 days.

How should ewes and lambs be identified? Flock ear tags are recommended for ewes and lambs, using a year-of-birth designation and a numeric number of lambs within year born. Limit number of digits to five. Registered ewes may be identified with last five digits of the registration number, if desired. Be consistent over the years.

How should stud rams be identified? Registered rams must be identified by last five digits of their registration number. Grade rams or rams in commercial flocks may be identified by ear tag or assigned a numerical code.

Table 1. Suggested Coded Remarks for Form ISPTP-1. (Space provided for up to three remarks. List on the line for lamb under "coded remarks" column.)

Code	Remarks
1	Premature birth
2	Born dead
3	Deformed lamb
4	Assisted with delivery of lamb
5	Lamb died within first 10 days
6	Abnormal udder (mastitis, etc.)
7	Ewe with no milk
8	Lamb with uneven jaw development (parrot or monkey mouth)
9	Lamb with turned-in eye lids
A	Ewe would not own lamb
B	Ewe developed pregnancy disease
C	Normal udder, but poor milking ewe
D	Abnormally thin ewe (lungers, etc.)
E	Over-fat ewe
F	Blind ewe
G	Ewe with chronic lameness
H	Ewe exhibited prolapse of reproductive organs
I	Lamb died between 10 and 30 days of age
J	Lamb died between 30 and 60 days of age
K	Lamb died between 60 and 90 days of age
L	Lamb suffered from starvation
M	Lamb suffers from pneumonia
N	Lamb suffers from injury
O	Lamb suffered from over-eating disease
P	Lamb suffered from stiff-lamb disease (white muscle disease)
Q	Lamb suffered from urinary calculi
R	Lamb suffered from prolapsed rectum
S	Lamb suffered from dog attack
T	Gave lamb away
U	Lamb unaccounted for at weighing (lost, stolen, etc.)
V	Sold lamb prior to 90 days of age
W	Lamb with excessive dark fiber in fleece
X	Lamb fleece lacks uniformity of grade
Y	Ewe fleece lacks uniformity of grade
Z	Ewe fleece extremely open (lacks density)

How much time is required to performance test a flock? Very little time is required to complete forms ISPTP-1 or ISPTP-2. The ease and time required to obtain growth data depends on the kind of handling and weighing facilities. Carcass data may be obtained through the various county, area or state carcass shows and breed association carcass programs.

Do I need a scale? Yes! Each breeder is responsible for providing a scale. Scales adequate for weighing sheep are not expensive and are essential tools in present-day sheep production-management programs.

Table 2. Suggested Weighing Schedule for 90-Day Weights.

Non-leap years		Leap years	
Lambing dates	Weigh date	Lambing dates	Weigh date
1/1 to 2/10	4/21	1/1 to 2/10	4/20
2/11 to 3/23	6/1	2/11 to 3/22	5/31
3/24 to 5/3	7/12	3/23 to 5/2	7/11
5/4 to 6/13	8/22	5/3 to 6/12	8/21
6/14 to 7/24	10/2	6/13 to 7/23	10/1
7/25 to 9/3	11/12	7/24 to 9/2	11/11
9/4 to 10/14	12/23	9/3 to 10/13	12/22
10/15 to 11/24	2/2	10/14 to 11/23	2/1
11/25 to 1/4	3/15*	11/24 to 1/3	3/14

*Weigh date is 3/14 if in leap year.

Table 3. Suggested Weighing Schedule for 210-Day Weights.

Non-leap years		Leap years	
Lambing dates	Weigh date	Lambing dates	Weigh date
1/1 to 3/2	8/29	1/1 to 3/1	8/28
3/3 to 5/2	10/29	3/2 to 5/1	10/28
5/3 to 7/2	12/29	5/2 to 7/1	12/28
7/3 to 9/1	2/28	7/2 to 8/31	2/27
9/2 to 11/1	4/30*	9/1 to 10/31	4/29
11/2 to 1/1	6/30*	11/1 to 12/31	6/29

*Weigh date is one day earlier if in leap year.

Do I need to weigh lambs at birth? No! Birth weight is not needed in calculating adjusted 90- and 210-day weights.

Who weighs the lambs? The breeder does his own weighing. He certifies the identification, weight records and carcass data reported on data forms ISPTP-1 and ISPTP-2. Technical assistance may be obtained from your area Extension sheep agent or state Extension sheep specialist.

How are records summarized? Data reported on form ISPTP-1 are punched on data cards. Records are summarized, adjusted and reported using a computer.

What is meant by adjusted weight? It is the weight of the lamb standardized for differences which are not heritable, such as age of ewe, age of lamb at weighing, sex of lamb and type of birth-type of rearing. The lamb 90-day weight is adjusted to a ewe lamb, single-born, single-reared, mature ewe (3 to 6 years of age) basis. The lamb 210-day (7 month) weight is adjusted by adding the adjusted 90-day weight and the product of 120 multiplied by the average daily gain between 90- and 210-day weights. The adjustment factors used in the Indiana Sheep Performance Testing Program are given in Table 4.

Are adjustments made for creep feeding? No! Weight records are not adjusted for creep feeding, since no two sheep producers have the same creep feeding program. All lambs in the flock should be handled the same for accurate comparison of their performance. If some lambs are creep fed and others not, the performance records for these two groups of lambs should be handled as two different groups and summarized separately.

What is weight ratio? It is a figure to express the superiority or inferiority in adjusted weight of an individual lamb relative to the average adjusted weight of all lambs of the same sex within the set of records being summarized. Hence, the 90- and 210-day adjusted weight ratios are calculated on a within-group sex basis as follows:

$$\frac{\text{Individual's adjusted weight}}{\text{Ave. adjusted weight of sex group}} \times 100$$

The adjusted weight ratio for an individual lamb gives the relative ranking of that lamb compared to others of the same sex. The adjusted weight ratio for the sire-sex average gives the relative ranking of all lambs of a given sex from a sire to the overall average of that sex.

Can one compare lambs born in different seasons? Yes, by summarizing the lamb records by seasons of birth. Seasonal and management differences do influence lamb weights. Therefore, records of lambs born in different seasons should be compared on the basis of their weight ratios rather than actual or adjusted weights.

Should performance records by used to compare differences between flocks? No! Most differences observed between flocks are environmental, i.e. due to differences in nutrition and management practices. The performance information is designed for use within your flock. Any comparison made between animals from two different flocks should be on the basis of weight ratios, not actual or adjusted weights.

How should ram lambs be gain-tested? Weigh all ram lambs between 70 and 110 days; then reweigh the rams with adjusted 90-day weight ratios of 90 or higher between 180 and 240 days, and complete a 210-Day Record on form ISPTP-1 so as to obtain an adjusted 210-day (7 month) adjusted weight and ratio.

During the feeding period, feed the rams a high-energy ration. A suggested ration is: 1175 pounds No. 2 shelled corn, 800 pounds good quality hay (mostly legume), 25 pounds soybean meal and antibiotic supplementation as needed. This ration may be hand-fed or self-fed. Provide proper salt and mineral supplementation during the period.

Table 4. Indiana Sheep Performance Testing Program Adjustment Factors (and How to Use Them).

Birth-rearing	Age of dam One year	 2 years or over 6 years	 3-6 years
Ewe Lamb			
Single raised as single	1.22	1.09	1.00
Single raised as twin	1.33	1.20	1.11
Twin raised as twin	1.33	1.20	1.11
Twin raised as single	1.28	1.14	1.05
Triplet raised as triplet	1.46	1.33	1.22
Triplet raised as twin	1.42	1.28	1.17
Triplet raised as single	1.36	1.21	1.11
Wether			
Single raised as single	1.19	1.06	.97
Single raised as twin	1.30	1.17	1.08
Twin raised as twin	1.30	1.17	1.08
Twin raised as single	1.25	1.11	1.02
Triplet raised as triplet	1.43	1.30	1.19
Triplet raised as twin	1.39	1.25	1.14
Triplet raised as single	1.33	1.18	1.08
Ram Lamb			
Single raised as single	1.11	.98	.89
Single raised as twin	1.22	1.09	1.00
Twin raised as twin	1.22	1.09	1.00
Twin raised as single	1.17	1.03	.94
Triplet raised as triplet	1.35	1.22	1.11
Triplet raised as twin	1.31	1.17	1.06
Triplet raised as single	1.25	1.10	1.00

*Example: To find *adjusted 90-day weight and adjusted 90-day weight ratio* of a single born and reared ram lamb from a 4-year-old ewe that weighed 75 pounds at 87 days of age, when all ram lambs in flock have an adjusted 90-day weight of 66 pounds, make the following calculations:

(1) WPDA = 75 lbs./87 days = 0.862 lbs./day
(2) Act. 90-day wt. = 0.862 lbs/day x 90 days = 77.6 lbs. = 78 lbs.
(3) Adj. 90-day wt. = 77.6 lbs. x 0.89 (adjustment factor)
= 69.1 lbs. = 69 lbs.
(4) Adj. 90-day wt. ratio = 69 lbs/66 lbs. (ram lamb average)
= 104.5 or 105

Are my performance records confidential? Yes! Each flock in the Indiana Sheep Performance Testing Program is assigned a flock code number. All records are processed, filed and reported by this code.

Can performance testing records be used in advertising my flock? Yes. However, performance records used in advertisements of sale catalogs should be brief, pertinent, current, complete and authentic. Use 90- and 210-day adjusted weights and ratios, plus carcass quality and cutability data. Avoid use of misleading or non-standardized data.

Are performance testing programs always successful? No. The success of a performance testing program depends on the integrity of the producer, accuracy of the data, and utilization of the information obtained when selecting flock replacements.

What is the relationship between the Hoosier Gold Medal Lamb Club and the Indiana Sheep Performance Testing Program?

1. Eligibility for participation in Gold Medal Lamb Club is established by weighing lambs at 90 days in the Indiana Sheep Performance Testing Program.

2. All ram and ewe lambs from registered rams and ewes, born between September 1 and March 31, with adjusted 90-day weight ratios of 95 or higher on a within-flock sex basis, are eligible for exhibition in approved Gold Medal Lamb Club Shows.

3. Exhibitor cards are prepared and forwarded for lambs eligible to participate in approved Gold Medal Shows.

4. Lambs can be qualified through the Indiana Sheep Performance Testing Program at no charge to the owner.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

Pigs to Pork

SELECTION

Cooperative Extension Service PURDUE UNIVERSITY Lafayette, Indiana

AS-315
Rev. 1971

INDIANA SWINE SIRE PROGENY TESTING PROGRAM –Rules and Regulations

PURPOSE

The Indiana Sire Progeny Testing Program offers swine breeders of Indiana an accurate record-keeping system for measuring brood sows and herd sire productivity and their progeny's gainability, feed conversion and carcass quality. The program is intended to assist the individual breeder in obtaining performance data through which superior strains within each breed may be evaluated and identified.

DIRECTION

1. Coordination of this program will be the responsibility of Animal Sciences Extension, Purdue University. (Additional copies of ISEP record-keeping forms are available from local County Extension Offices; Area Extension Swine Agents; or the Swine Extension Section, Animal Sciences Department, Purdue University, Lafayette, Indiana 47907.)

2. The general policy, rules and regulations of this program will be subject to the recommendations of an Advisory Committee. This Advisory Committee shall consist of two men from each recognized Indiana swine breed association -- each man to be elected or appointed for a term of two years.

3. Certifications for this program will be authorized and awarded by the Executive Committee of the Indiana Livestock Breeders Association.

PARTICIPATION

Any swine breeder of Indiana may participate in this program provided he can meet the eligibility requirements.

ELIGIBILITY

Litters must be eligible for registry in the respective breed associations. (It is suggested that pigs meet the production registry weight and number requirements of the respective breed.)

TESTING PROCEDURE

1. The test group shall consist of a minimum of 12 or more market swine (barrows or gilts) from the same sire and five or more sows.

2. The test group may consist of a combination of either or both On-Farm groups and Swine Evaluation Station litters.

3. Pigs in the test group must be farrowed within a 12-month period.

4. Sows of test group pigs (five minimum) shall include not more than one full-sister or one dam-daughter combination.

5. Pigs in the test group will be individually identified by litter and pig (1-3-9-27-81 ear-notching system recommended).

6. Pigs in the test group will be individually weighed and started on test between 35 and 64 days of age and continue on test until reaching an average test group market-weight of 220 pounds. On- and off-test weights will be reported on ISEP Form 3.

7. All pigs represented in the test group shall have been nominated at the time the test group is weighed on test or within 10 days, using ISEP Form 1, Nomination Sheet. Test record data will not be summarized if this requirement is not met.

8. Once the test has started, there shall be no substituting of pigs. However, in the case of injury or sickness, pigs can be weighed off test. This off-test weight must be reported within 10 days, using ISEP Form 2, Pig Removal Notification Sheet.

9. Test group pigs shall be self-fed. Suggested rations are those used at the Indiana Swine Evaluation Station. Copies may be obtained from Swine Extension Section, Animal Sciences Department, Purdue University, Lafayette, Indiana 47907.

10. Complete test group feed records will be reported on ISEP Form 3, Testing Program Data Sheet.

11. Completeness and accuracy of all pig weights and feed records shall be certified by the cooperator.

12. Charges shall be $25.00 per test group. Checks to cover charges shall be made payable to Indiana Sire Progeny Testing Program and mailed with the completed ISEP Form 1 when test begins.

TEST AREA

The test area may be a total confinement area, dry lot or pasture. A description of the test area must be reported on ISEP Form 3.

FEED EFFICIENCY

The feed efficiency values reported for this program will be on a sire group basis. The feed efficiency standard will be 325 pounds of feed per 100 pounds of gain.

GAINABILITY AND CARCASS STANDARDS

1. Test group pigs will be weighed off test when the average weight of the test group is 220 pounds.

2. Carcass certification standards will be those recommended by the National Association of Swine Records. These standards are on an adjusted 220-pound basis (with no adjustment for sex):

a. Age at 220 pounds (maximum)-180 days
b. Loin-eye area (minimum)-4.50 sq. in.
c. Carcass Length (minimum)-29.5 in.
d. Carcass backfat (maximum)-1.50 in.

TEST DATA

1. At completion of the test, the cooperator will forward completed ISEP Form 3 to: Indiana Sire Progeny Testing Program, Swine Extension Section, Animal Sciences Department, Purdue University, Lafayette, Indiana 47907.

2. Also at completion of the test, the cooperator will select, tattoo and slaughter 80% of the test group animals. These will be slaughtered at a meat packing firm where satisfactory results can be obtained for collection of necessary data.

3. The cooperator then completes ISEP Form 4, Swine Carcass Cutout Work Sheet, by listing breed, name, address, pig number (ear notches), tattoo and liveweight. This completed ISEP Form 4 shall accompany the pigs to slaughter.

4. The cooperating packer will report necessary data (carcass length, backfat and loin-eye area) on ISEP Form 4. He should, if possible, report values for hot carcass weight, trimmed ham weight, trimmed loin weight, and meat quality ratings for color-firmness and marbling.

5. The cooperating packer should complete Form 4 by listing date slaughtered, name of cooperating packer and name of data taker. The completed ISEP Form 4 should then be forwarded to Indiana Sire Progeny Testing Program, Swine Extension Section, Animal Sciences Department, Purdue University, Lafayette, Indiana 47907.

CERTIFICATION

1. If the test group meets the feed efficiency requirements, and if two of the littermate pigs are from a production registry litter, and if each pig meets the carcass standards, the litter will be recognized as an Indiana On-Farm Certified Meat Litter. An Indiana On-Farm Certified Meat Litter Certificate will be awarded by the Executive Committee of the Indiana Livestock Breeders Association.

2. An Indiana Superior Certified Meat Sire Certificate will be awarded by the Executive Committee of the Indiana Livestock Breeders Association for a boar that has sired five litters which have qualified as an Indiana On-Farm Certified Meat Litter. These five litters must be from five sows which include not more than one full-sister or one dam-daughter combination.

3. An Indiana Superior Meat Sire Certificate will be awarded by the Executive Committee of the Indiana Livestock Breeders Association for a boar when the average for his progeny's test group meets the feed requirements and carcass standards. The test group shall consist of 12 or more pigs from five or more sows which include not more than one full-sister or one dam-daughter pair. A minimum of 80% of the test group animals shall be slaughtered.

PUBLICATION OF DATA

1. All data summarized for the program will be made available to the breeder and the national breed association represented. All data will be reported on a 220-pound adjusted basis (no adjustment for sex).

2. Complete records of performance on all test groups will be released for publication periodically, with complete identification given for each test group.

Cooperative Extension Work in Agriculture and Home Economics
State of Indiana, Purdue University
and the United States Department of Agriculture Cooperating
H. G. Diesslin, Director, Lafayette, Indiana
Issued in furtherance of the Acts of May 8 and June 30, 1914.

ISEP Form 4

Swine Carcass Cut-Out Work Sheet

Indiana Sire Progeny Testing Program

Breed ________________ Owner ________________

Address ________________________ ZIP ________

Owner No. ________________ (leave blank) County ________________

Carcass data	Individual pigs														
*Number (ear notch)															
*Tattoo															
*Live weight															
Hot carcass weight															
Chilled carcass weight															
Carcass trim weight															
*Carcass length															
*Backfat --Shoulder															
*Backfat --Back															
*Backfat --Lumbar															
*Average backfat															
*Loin eye area															
Ham weight															
Loin weight															
Color-firmness score															
Marbling score															

* Necessary data; other data optional.

Date Slaughtered ________ Cooperating Packer ____________ Name of Data Taker ____________

Cooperating packer must mail this sheet within 10 days of slaughter date to the:

Indiana Sire Progeny Testing Program
Swine Extension Section, Animal Sciences Department
Lilly Hall of Life Sciences, Purdue University
Lafayette, Indiana 47907

ISEP Form 3

Test Group Data Form and Feed Record

Indiana Sire Progeny Testing Program

Breed__________ Owner__________

Address__________ ZIP__________

Owner No.__________ County__________

Siré of
Test Group: Name__________ Reg. No.__________

TEST GROUP IDENTIFICATION AND PRODUCTION DATA

Sow registration number	Date farrowed	Litter number	Pig number	Sex (B-G)	On-test		Off-test	
					Date	Weight	Date	Weight

Owner must mail this sheet within 10 days of the test completion date to the:

Indiana Sire Progeny Testing Program
Swine Extension Section, Animal Sciences Department
Lilly Hall of Life Sciences, Purdue University
Lafayette, Indiana 47907

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(OVER)

TEST GROUP FEED RECORD

Date	Weight of feed		
	In	Back	Consumed to date

Date	Weight of feed		
	In	Back	Consumed to date
TOTAL =			

Description of Test Area

Please describe, in detail, the test area, giving type of surface, kind, size, etc:

Validation of Test Records

I hereby certify that the weights, and feed records given on this data sheet were obtained by me or under my supervision and that they are valid. The test group was full-fed a ______% protein ration to 120 pounds, and a ________% protein ration from 120 pounds to the end of the test weight.

Signature of Owner 322

Date ____________________

(OVER)

ISEP Form 2

Pig Removal Notification Form

Indiana Sire Progeny Testing Program

Breed________________ Owner________________

Address________________ ZIP________

Owner No.________________ County________________
(leave blank)

Sire of
Test Group: Name________________ Reg. No.________________

IDENTIFICATION OF PIG(S) REMOVED FROM TEST

Sow registration number	Date farrowed	Litter number	Pig number	Sex (B-G)	On-test		Off-test	
					Date	Weight	Date	Weight

Owners must mail this sheet within 10 days after pigs are weighed off test to the:

Indiana Sire Progeny Testing Program
Swine Extension Section, Animal Sciences Department
Lilly Hall of Life Sciences, Purdue University
Lafayette, Indiana 47907

ISEP Form 1

Nomination Form

INDIANA SIRE PROGENY TESTING PROGRAM

Breed ______________________ Owner ______________________

Address ______________________ ZIP ____________

Owner No. ______________________ County ______________________
(leave blank)

Sire of
Test Group: Name ______________________ Reg. No. ____________

IDENTIFICATION OF TEST GROUP PIGS

Sow registration number	Date farrowed	Litter number	Pig number	Sex (B-G)	On-test date	On-test weight

Owner must mail this sheet within 10 days after the test begins to the:

Indiana Sire Progeny Testing Program
Swine Extension Section, Animal Sciences Department
Lilly Hall of Life Sciences, Purdue University
Lafayette, Indiana 47907

AS-380 • Rev. 1977

animal sciences swine

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA 47907

Indiana On-Farm Boar Testing Program Rules and Regulations

K. J. Drewry, Animal Sciences Department, Purdue University

Purpose

The Indiana On-Farm Boar Testing Program offers Hoosier swine breeders an accurate record-keeping system for determining sow and herd sire productivity through measurements of their boar progeny's gainability, feed conversion, carcass quality (as indicated by backfat and loineye) and visual appraisal (type and structural soundness). The program is intended to: (1) assist breeders in obtaining data to identify superior strains, lines or breeds; (2) assist breeders in selection of replacement and sale boars; and (3) supplement similar data obtained by breeders on boars from their herds at the Indiana Boar Test Station.

Direction

Coordination of the program is the responsibility of the Swine Extension Section, Animal Sciences Department, Purdue University. The general policy, rules and regulations of this program are subject to the recommendations of the Indiana Swine Evaluation Advisory Committee. The Advisory Committee consists of purebred breeders, commercial producers and extension personnel.

Participation

Any swine breeder in Indiana may participate in the program, provided he can meet the eligibility requirements.

Eligibility

Only boar pigs from litters farrowed in Indiana and owned by a resident of the state are eligible. The sow must be in the ownership of the cooperator at farrowing.

Identification

Boar pigs to be evaluated must be individually identified by litter and pig, with the 1-3-9-27-81 ear-notching system recommended. Sires and dams of test boars may be identified by: ear-notch, ear-tag or last five digits of registration number. Sires may also be identified by herd name (five digits). Be consistent over time with identification of sire and dam.

Breeding

Boar pigs of any breed or breed combination may be evaluated in this program.

Traits Measured

Required measurements for this program include: test daily gain and adjusted backfat. It is recommended, but not required, that the cooperator also obtain measurements of pen feed consumption, adjusted loineye area and visual score.

Testing Procedures

A minimum of 12 boar pigs from the herd shall be evaluated within a farrowing season. It is recommended (although not required) that, if possible, all boar pigs in a pen be sired by the same boar. The cooperator may choose to evaluate the boar pigs with a smaller number of boar pigs per pen due to management considerations.

The data forms used with this program shall consist of ISEP Form 5, "Indiana On-Farm Boar and Gilt Testing Programs Evaluation Work Sheet," and ISEP Form 6, "Test Pen Feed Record and Parentage Identification Record," if pen feed consumption is measured. Copies of these forms may be obtained from the Animal Sciences Department, Purdue University, West Lafayette, Ind. 47907; or from any area Extension livestock agent or county Extension office. (Samples of ISEP Forms 5 and 6 are at the end of this publication.)

The cooperator should complete one ISEP Form 5 for each test pen, giving the county and his name and address, and checking "pig sex code" box (1 = boar). (The herd code will be assigned by the Indiana Swine Evaluation Program Coordinator). Make entries in the right-most-part of all columns, especially for ear notches, sire name or number, number farrowed, number weaned and on-test weight. Insert leading zeros on all single month and day entries—e.g., February 9 would be recorded as 02 09. Use appropriate class, sex and breed codes as given at the bottom of Form 5.

Record the following information on ISEP Form 5 for each boar pig in the test pen including: *pen number; boar pig ear notches; sire records*—herd name or number (limit 5 letters or numbers), class and breed; *dam records*—year farrowed, ear notches, class and breed; and *litter records for test boar pigs*—date farrowed, number farrowed and number weaned.

All boar pigs in a test pen will be individually weighed and started on test when the average weight of boars in the pen is between 60 and 70 pounds, and they continue on test until the test pen average is 220 pounds. On- and off-test weights and dates for individual boar pigs in the test pen will be reported on ISEP Form 5. Feed consumed by the test pen is not required. However, if the cooperator does elect to measure pen feed consumption, it will be reported on ISEP Form 6, with one Form 5 and one Form 6 being completed for each test pen.

After the boars have been weighed on-test, record on ISEP Form 6 the sire's herd name or number, official name and registration number, and the dam's ear notches, official name and registration number for all boars in a test pen.

Once the test has started, there shall be no substituting of boars. However, in the case of death, injury or sickness, boars may be weighed off-test. Report the off-test weight and data on ISEP Form 5.

The test group boars shall be self-fed. Since boars are being evaluated, the ration should be higher in protein than common growing-finishing swine rations. Recommended rations are: (a) *up to 120 pounds*—16-18% protein and not over 5% fiber; and (b) *120 pounds to end of test*—15-17% protein and not over 5% fiber. Copies of the suggested test and conditioner rations may be obtained from the Indiana Swine Evaluation Program Coordinator at Purdue. Feed consumption for each test will be reported using ISEP Form 6.

Test Area

The test area may be total confinement, dry lot or pasture. It is suggested, however, that boars be evaluated on concrete in either total or partial confinement facilities. A description of the test area must be reported on ISEP Form 6.

Gainability and Feed Efficiency

Test daily gain for each boar will be calculated using test weight gain and days on test. If pen feed consumption is measured, the feed efficiency values reported for boar pigs will be on a pen basis, with the weight gain and feed consumption of boars in the pen used in calculating the pen feed efficiency. Feed efficiency values are most useful when boar pigs in the pen group are from the same sire.

Backfat, Loineye and Visual Score

At completion of the test or when each boar weighs between 200 and 240 pounds, the cooperator shall complete ISEP Form 5 by obtaining backfat measurements, loineye at the last rib and a visual score for each boar in the test pen. The backfat and loineye values reported shall be adjusted to 230-pound basis. Loineye at the last rib is a recommended measure but is not required.

Backfat at the shoulder, back and loin may be determined either with the mechanical probe 2 inches off the middle or with the sonoray or similar method. Adjust backfat to 230-pound basis using the values in Table 1. Record values of 1.10 and .90 as 110 and 090, respectively.

Loineye area at the last rib, if measured, may be determined with the sonoray or similar method. Adjust to 230-pound basis using the values in Table 2. Record loineye values of 6.25 and 4.99 as 625 and 499, respectively.

The visual score may be assigned by the cooperator, or he may choose to have a committee of fellow breeders assist in determining visual score for the boars. If so, the visual score reported for the boar shall be the average score of the committee. Items to consider when assigning visual score shall be those related to structural soundness and visual acceptability including: freedom of movement, bone size, scale, leg length and placement (including correctness of pastern),

Table 1. Backfat Thickness Adjusted to 230 Pounds Live Weight.*

Average actual backfat	Actual weight (in pounds) when measured																		
	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280
in.										inch									
.40	.46	.46	.45	.44	.43	.42	.42	.41	.40	.39	.38	.38	.37	.36	.35	.34	.34	.33	.32
.45	.52	.51	.50	.50	.49	.48	.47	.46	.45	.44	.43	.42	.41	.41	.40	.39	.38	.37	.36
.50	.58	.57	.56	.55	.54	.53	.52	.51	.50	.49	.48	.47	.46	.45	.44	.43	.42	.41	.40
.55	.64	.63	.62	.61	.59	.58	.57	.56	.55	.54	.53	.52	.51	.50	.48	.47	.46	.45	.44
.60	.70	.68	.67	.66	.65	.64	.62	.61	.60	.59	.58	.56	.55	.54	.53	.52	.50	.49	.48
.65	.75	.74	.73	.72	.70	.69	.68	.66	.65	.64	.62	.61	.60	.59	.57	.56	.55	.53	.52
.70	.81	.78	.78	.77	.76	.74	.73	.71	.70	.69	.67	.66	.64	.63	.62	.60	.59	.57	.56
.75	.87	.86	.84	.83	.81	.80	.78	.77	.75	.74	.72	.71	.69	.68	.66	.65	.63	.62	.60
.80	.93	.91	.90	.88	.86	.85	.83	.82	.80	.78	.77	.75	.74	.72	.70	.69	.67	.66	.64
.85	.99	.97	.95	.94	.92	.90	.88	.87	.85	.83	.82	.80	.78	.77	.75	.73	.71	.70	.68
.90	1.04	1.03	1.01	.99	.97	.95	.94	.92	.90	.88	.86	.85	.83	.81	.79	.77	.76	.74	.72
.95	1.10	1.08	1.06	1.05	1.03	1.01	.99	.97	.95	.93	.91	.89	.87	.86	.84	.82	.80	.78	.76
1.00	1.16	1.14	1.12	1.10	1.08	1.06	1.04	1.02	1.00	.98	.96	.94	.92	.90	.88	.86	.84	.82	.80
1.05	1.22	1.20	1.18	1.16	1.13	1.11	1.09	1.07	1.05	1.03	1.01	.99	.97	.95	.92	.90	.88	.86	.84
1.10	1.28	1.25	1.23	1.21	1.19	1.17	1.14	1.12	1.10	1.08	1.06	1.03	1.01	.99	.97	.95	.92	.90	.88
1.15	1.33	1.31	1.29	1.27	1.24	1.22	1.20	1.17	1.15	1.13	1.10	1.08	1.06	1.04	1.01	.99	.97	.94	.92
1.20	1.39	1.37	1.35	1.32	1.30	1.27	1.25	1.22	1.20	1.18	1.15	1.13	1.10	1.08	1.06	1.03	1.01	.98	.96
1.25	1.45	1.43	1.40	1.38	1.35	1.33	1.30	1.28	1.25	1.23	1.20	1.18	1.15	1.13	1.10	1.08	1.05	1.03	1.00
1.30	1.51	1.48	1.46	1.43	1.40	1.38	1.35	1.33	1.30	1.27	1.25	1.22	1.20	1.17	1.14	1.12	1.09	1.07	1.04
1.35	1.57	1.54	1.51	1.49	1.46	1.43	1.40	1.38	1.35	1.32	1.30	1.27	1.24	1.22	1.19	1.16	1.13	1.11	1.08
1.40	1.62	1.60	1.57	1.54	1.51	1.48	1.46	1.43	1.40	1.37	1.34	1.32	1.29	1.26	1.23	1.20	1.18	1.15	1.12
1.45	1.68	1.65	1.62	1.60	1.57	1.54	1.51	1.48	1.45	1.42	1.39	1.36	1.33	1.31	1.28	1.25	1.22	1.19	1.16
1.50	1.74	1.71	1.68	1.65	1.62	1.59	1.56	1.53	1.50	1.47	1.44	1.41	1.38	1.35	1.32	1.29	1.26	1.23	1.20
1.55	1.80	1.77	1.74	1.71	1.67	1.64	1.61	1.58	1.55	1.52	1.49	1.46	1.43	1.40	1.36	1.33	1.30	1.27	1.24
1.60	1.86	1.82	1.79	1.76	1.73	1.70	1.66	1.63	1.60	1.57	1.54	1.50	1.47	1.44	1.41	1.38	1.34	1.31	1.28

* Adjusted backfat = [(230 - actual weight) x .004) + 1.0] x average actual backfat

Table 2. Loineye Area Adjusted to 230 Pounds Live Weight.*

Actual loineye	Actual weight (in pounds) when measured																		
	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280
sq. in.										square inch									
3.50	4.10	4.03	3.95	3.88	3.80	3.73	3.65	3.58	3.50	3.43	3.35	3.28	3.20	3.13	3.05	2.98	2.90	2.83	2.75
3.70	4.30	4.23	4.15	4.08	4.00	3.93	3.85	3.78	3.70	3.63	3.55	3.48	3.40	3.33	3.25	3.18	3.10	3.03	2.95
3.90	4.50	4.43	4.35	4.28	4.20	4.13	4.05	3.98	3.90	3.83	3.75	3.68	3.60	3.53	3.45	3.38	3.30	3.23	3.15
4.10	4.70	4.63	4.55	4.48	4.40	4.33	4.25	4.18	4.10	4.03	3.95	3.88	3.80	3.73	3.65	3.58	3.50	3.43	3.35
4.30	4.90	4.83	4.75	4.68	4.60	4.53	4.45	4.38	4.30	4.23	4.15	4.08	4.00	3.93	3.85	3.78	3.70	3.63	3.55
4.50	5.10	5.03	4.95	4.88	4.80	4.73	4.65	4.58	4.50	4.43	4.35	4.28	4.20	4.13	4.05	3.98	3.90	3.83	3.75
4.70	5.30	5.23	5.15	5.08	5.00	4.93	4.85	4.78	4.70	4.63	4.55	4.48	4.40	4.33	4.25	4.18	4.10	4.03	3.95
4.90	5.50	5.43	5.35	5.28	5.20	5.13	5.05	4.98	4.90	4.83	4.75	4.68	4.60	4.53	4.45	4.38	4.30	4.23	4.15
5.10	5.70	5.63	5.55	5.48	5.40	5.33	5.25	5.18	5.10	5.03	4.95	4.88	4.80	4.73	4.65	4.58	4.50	4.43	4.35
5.30	5.90	5.83	5.75	5.68	5.60	5.53	5.45	5.38	5.30	5.23	5.15	5.08	5.00	4.93	4.85	4.78	4.80	4.63	4.55
5.50	6.10	6.03	5.95	5.88	5.80	5.73	5.65	5.58	5.50	5.43	5.35	5.28	5.20	5.13	5.05	4.98	4.90	4.83	4.75
5.70	6.30	6.23	6.15	6.08	6.00	5.93	5.85	5.78	5.70	5.63	5.55	5.48	5.40	5.33	5.25	5.18	5.10	5.03	4.95
5.90	6.50	6.43	6.35	6.28	6.20	6.13	6.05	5.98	5.90	5.83	5.75	5.68	5.60	5.53	5.45	5.38	5.30	5.23	5.15
6.10	6.70	6.63	6.55	6.48	6.40	6.33	6.25	6.18	6.10	6.03	5.95	5.88	5.80	5.73	5.65	5.58	5.50	5.43	5.35
6.30	6.90	6.83	6.75	6.68	6.60	6.53	6.45	6.38	6.30	6.23	6.15	6.08	6.00	5.93	5.85	5.78	5.70	5.63	5.55
6.50	7.10	7.03	6.95	6.88	6.80	6.73	6.65	6.58	6.50	6.43	6.35	6.28	6.20	6.13	6.05	5.98	5.90	5.83	5.75
6.70	7.30	7.23	7.15	7.08	7.00	6.93	6.85	6.78	6.70	6.63	6.55	6.48	6.40	6.33	6.25	6.18	6.10	6.03	5.95
6.90	7.50	7.43	7.35	7.28	7.20	7.13	7.05	6.98	6.90	6.83	6.75	6.68	6.60	6.53	6.45	6.38	6.30	6.23	6.15

* Adjusted loineye = actual loineye + 0.015(230 - actual weight)

chest capacity, overall balance, body length, underline (prominence, spacing and number of teat) and overall expression of masculinity. A suggested visual score card is presented in Figure 1.

The visual score for most boars will fall in the 20- to 80-point range, with most being between 35 and 65. Extremely poor boars will score below 20 and extremely outstanding boars will score above 80.

VISUAL SCORE CARD
Indiana Swine Testing Program
(Station and On-Farm)

I. **Body Conformation (30 total points)**
  a Body length 1 2 3 4 5 6 7 8 (circle one) ______
  b Bone 1 2 3 4 5 6 7 8 (circle one) ______
    To be evaluated
      1 Diameter, circumference or ruggedness of bone
  c Body capacity 1 2 3 4 5 6 7 8 9 10 11 12
    13 14 (circle one) ______
    To be evaluated
      1 Depth of side
      2 Width of chest floor
      3 Depth through chest
      4 Body width

II. **Feet and Legs (30 total points)** Animals with feet and leg scores of less than 18 points should receive a "US" in the Coded Remarks column on ISEP Form 5
  a Front 1 2 3 4 5 6 7 8 9 10 11 12
    13 14 15 (circle one) ______
    To be evaluated
      1 Straightness of front leg
      2 Slope of pastern
      3 Toes of even size
      4 Freedom of movement
  b Rear 1 2 3 4 5 6 7 8 9 10 11 12
    13 14 15 (circle one) ______
    To be evaluated
      1 Set to hock, position of leg
      2 Strength of pastern
      3 Toes of even size
      4 Squareness of foot setting on ground
      5 Freedom of movement

III. **Underline (30 total points)** Animals with less than 12 nipples (6 on each side) or animals with inverted nipples should receive a "BUL" in the Coded Remarks column on ISEP Form 5
  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
  19 20 21 22 23 24 25 26 17 18 29 30 (circle one)
  ______
    To be evaluated
      1 Number of teats
      2 Prominence of teats
      3 Inversions (Any teat spot on which the end of the nipple cannot be seen will be classified as an inverted nipple.)
      4 Spacing of nipples
      5 Presence of pin nipples
      6 Presence of blind teats

IV. **Breed Character (10 total points)**
  1 2 3 4 5 6 7 8 9 10 (circle one) ______
    To be evaluated
      1 Head and ears
      2 Color markings
      3 Breed conformation traits

TOTAL POINTS ______

Figure 1. Suggested Visual Score Card.

After all test measurements have been made on boars in each test pen, the cooperator should sign ISEP Form 5, and complete and sign ISEP Form 6.

Data Summarization

When completed, the cooperator should forward the original (white) copy of ISEP Form 5 and ISEP Form 6 for each test pen to the Indiana Swine Evaluation Programs, Swine Extension Section, Animal Sciences Department, Purdue University, West Lafayette, Indiana 47907. *The cooperator should keep the carbon (yellow) copy of ISEP Form 5 for his files.*

Index Value

Boars will be indexed using the deviation of their records for daily gain (DG) and adjusted backfat (BF) from the average daily gain ($\overline{DG}$) and adjusted backfat ($\overline{BF}$) records of all boars being summarized at a given time. Thus, the breeder should decide whether he wants to summarize by pen, farrowing month or farrowing season, since the boars' final index will depend upon the particular average from which their individual record is deviated.

An index value for each boar will be calculated using the following index: $100 + 110(DG - \overline{DG}) - 105(BF - \overline{BF})$. The average index within the summary-group will be 100 points. Approximately two-thirds of the boars within a summary-group will have indexes between 75 and 125 points.

Breeder's Summary

All test data will be summarized by computer and returned from Purdue to breeder within 10 to 14 days. This summary will contain the following:

1. Boar identification data (*pig*—number, class, breed, sex and pen; *sire*—name and breed; *dam*—year, number, breed, and litter farrowing date).
2. Boar test data (number farrowed; number weaned; age at 230 pounds; test records for daily gain, adjusted backfat and, if measured, feed efficiency, adjusted loineye area and visual score; and boar ratio values for daily gain, adjusted backfat and, if measured, feed efficiency, adjusted loineye area and visual score; index and star rating).

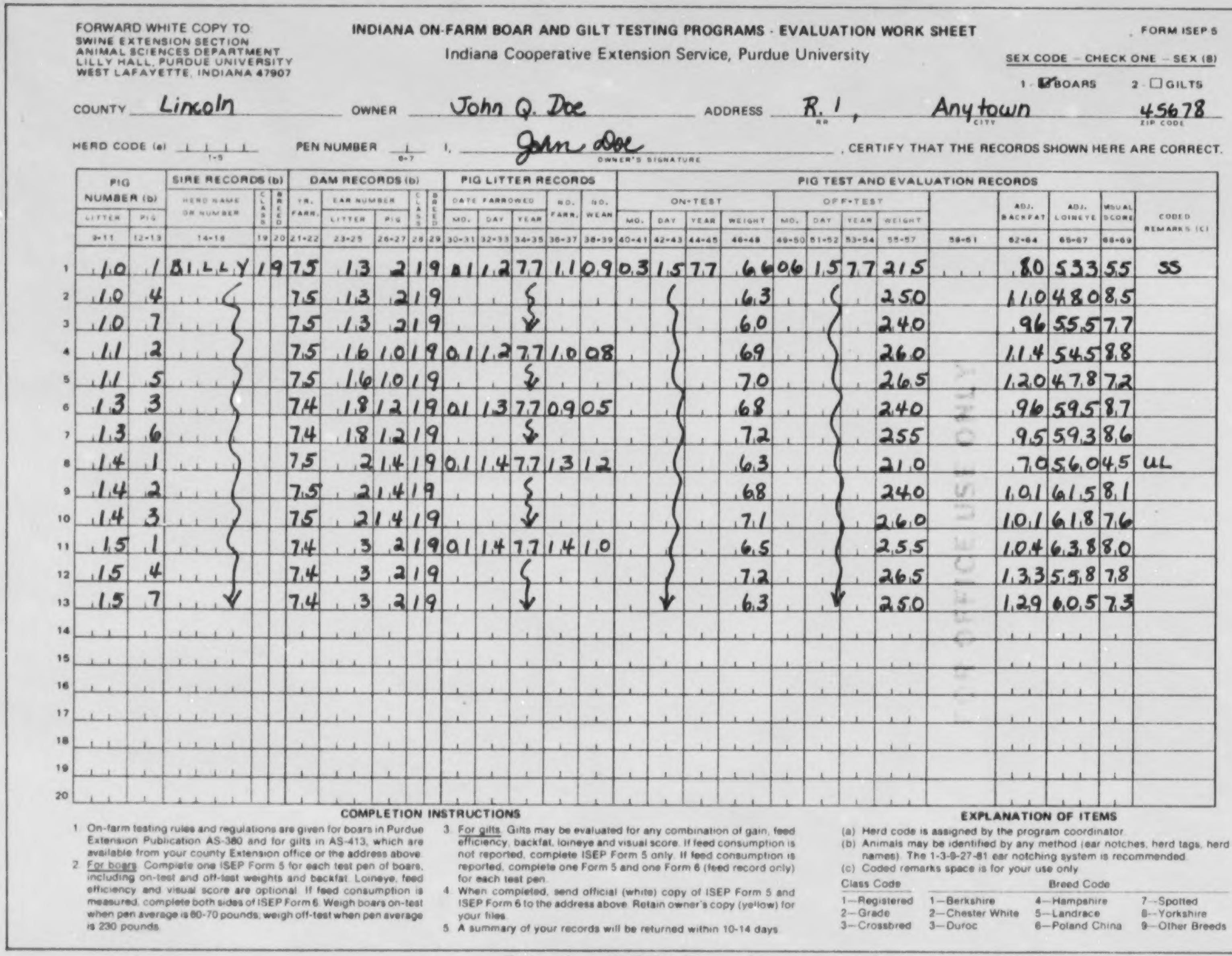
Sire and summary-group averages will also be given for: number farrowed, number weaned, age in days at 230 pounds, test records and boar ratio values for traits measured and index value. In addition, with each summary the breeder will receive an up-dated rolling herd average for: number farrowed, number weaned, age in days at 230 pounds, daily gain, adjusted backfat, feed efficiency, adjusted loineye area and visual score.

Star Rating

Tested boars will be assigned a "star rating" according to the index value ranges as follows:

One	80-89
Two	90-99
Three	100-109
Four	110-119
Five	120-129
Six	130 plus

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.



FORWARD WHITE COPY TO:
SWINE EXTENSION SECTION
ANIMAL SCIENCES DEPARTMENT
LILLY HALL, PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

INDIANA ON-FARM BOAR AND GILT TESTING PROGRAMS · EVALUATION WORK SHEET

Indiana Cooperative Extension Service, Purdue University

FORM ISEP 5

SEX CODE – CHECK ONE – SEX (8)

1 · ☑ BOARS 2 · ☐ GILTS

COUNTY Lincoln OWNER John Q. Doe ADDRESS R. 1 (RR), Anytown (CITY) 45678 (ZIP CODE)

HERD CODE (a) (1-5) PEN NUMBER (6-7) I, John Doe (OWNER'S SIGNATURE), CERTIFY THAT THE RECORDS SHOWN HERE ARE CORRECT.

	PIG NUMBER (b)		SIRE RECORDS (b)			DAM RECORDS (b)					PIG LITTER RECORDS					PIG TEST AND EVALUATION RECORDS												
							EAR NUMBER				DATE FARROWED					ON-TEST				OFF-TEST								
	LITTER	PIG	HERD NAME OR NUMBER	CLASS	BREED	YR. FARR.	LITTER	PIG	CLASS	BREED	MO.	DAY	YEAR	NO. FARR.	NO. WEAN	MO.	DAY	YEAR	WEIGHT	MO.	DAY	YEAR	WEIGHT		ADJ. BACKFAT	ADJ. LOINEYE	VISUAL SCORE	CODED REMARKS (C)
	9-11	12-13	14-18	19	20	21-22	23-25	26-27	28	29	30-31	32-33	34-35	36-37	38-39	40-41	42-43	44-45	46-48	49-50	51-52	53-54	55-57	58-61	62-64	65-67	68-69	
1	10	1	BILLY	1	9	75	13	2	1	9	01	12	77	11	09	03	15	77	66	06	15	77	215		80	533	55	SS
2	10	4	↓			75	13	2	1	9			↓				↓		63		↓		250		110	480	85	
3	10	7	↓			75	13	2	1	9			↓				↓		60		↓		240		96	555	77	
4	11	2	↓			75	16	10	1	9	01	12	77	10	08		↓		69		↓		260		114	545	88	
5	11	5	↓			75	16	10	1	9			↓				↓		70		↓		265		120	478	72	
6	13	3	↓			74	18	12	1	9	01	13	77	09	05		↓		68		↓		240		96	595	87	
7	13	6	↓			74	18	12	1	9			↓				↓		72		↓		255		95	593	86	
8	14	1	↓			75	2	14	1	9	01	14	77	13	12		↓		63		↓		210		70	560	45	UL
9	14	2	↓			75	2	14	1	9			↓				↓		68		↓		240		101	615	81	
10	14	3	↓			75	2	14	1	9			↓				↓		71		↓		260		101	618	76	
11	15	1	↓			74	3	2	1	9	01	14	77	14	10		↓		65		↓		255		104	638	80	
12	15	4	↓			74	3	2	1	9			↓				↓		72		↓		265		133	558	78	
13	15	7	↓			74	3	2	1	9			↓				↓		63		↓		250		129	605	73	
14																												
15																												
16																												
17																												
18																												
19																												
20																												

FOR OFFICE USE ONLY

COMPLETION INSTRUCTIONS

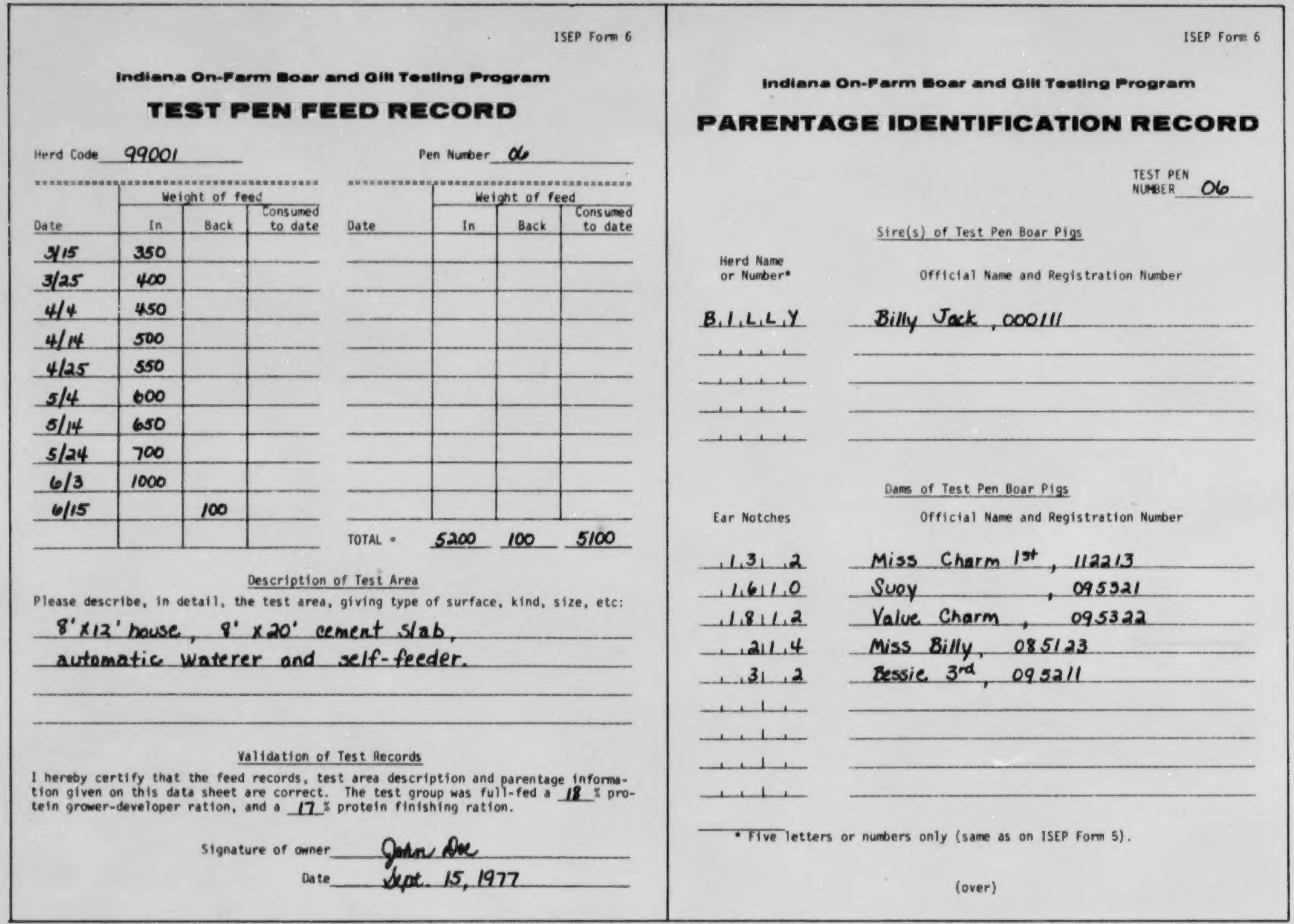
1. On-farm testing rules and regulations are given for boars in Purdue Extension Publication AS-380 and for gilts in AS-413, which are available from your county Extension office or the address above.
2. For boars. Complete one ISEP Form 5 for each test pen of boars, including on-test and off-test weights and backfat. Loineye, feed efficiency and visual score are optional. If feed consumption is measured, complete both sides of ISEP Form 6. Weigh boars on-test when pen average is 60-70 pounds, weigh off-test when pen average is 230 pounds.
3. For gilts. Gilts may be evaluated for any combination of gain, feed efficiency, backfat, loineye and visual score. If feed consumption is not reported, complete ISEP Form 5 only. If feed consumption is reported, complete one Form 5 and one Form 6 (feed record only) for each test pen.
4. When completed, send official (white) copy of ISEP Form 5 and ISEP Form 6 to the address above. Retain owner's copy (yellow) for your files.
5. A summary of your records will be returned within 10-14 days.

EXPLANATION OF ITEMS

(a) Herd code is assigned by the program coordinator.
(b) Animals may be identified by any method (ear notches, herd tags, herd names). The 1-3-9-27-81 ear notching system is recommended.
(c) Coded remarks space is for your use only.

Class Code	Breed Code		
1—Registered	1—Berkshire	4—Hampshire	7—Spotted
2—Grade	2—Chester White	5—Landrace	8—Yorkshire
3—Crossbred	3—Duroc	6—Poland China	9—Other Breeds

Sample of ISEP Form 5.



ISEP Form 6

Indiana On-Farm Boar and Gilt Testing Program

TEST PEN FEED RECORD

Herd Code 99001 Pen Number 06

	Weight of feed		
Date	In	Back	Consumed to date
3/15	350		
3/25	400		
4/4	450		
4/14	500		
4/25	550		
5/4	600		
5/14	650		
5/24	700		
6/3	1000		
6/15		100	

	Weight of feed		
Date	In	Back	Consumed to date
TOTAL =	5200	100	5100

Description of Test Area

Please describe, in detail, the test area, giving type of surface, kind, size, etc:

8'x12' house, 8' x 20' cement slab, automatic waterer and self-feeder.

Validation of Test Records

I hereby certify that the feed records, test area description and parentage information given on this data sheet are correct. The test group was full-fed a 18 % protein grower-developer ration, and a 17 % protein finishing ration.

Signature of owner John Doe

Date Sept. 15, 1977

ISEP Form 6

Indiana On-Farm Boar and Gilt Testing Program

PARENTAGE IDENTIFICATION RECORD

TEST PEN NUMBER 06

Sire(s) of Test Pen Boar Pigs

Herd Name or Number*	Official Name and Registration Number
B I L L Y	Billy Jack, 000111

Dams of Test Pen Boar Pigs

Ear Notches	Official Name and Registration Number
1 3 2	Miss Charm 1st, 112213
1 6 1 0	Suoy, 095321
1 8 1 2	Value Charm, 095322
2 1 4	Miss Billy, 085123
3 2	Bessie 3rd, 095211

* Five letters or numbers only (same as on ISEP Form 5).

(over)

Sample of ISEP Form 6.

AS-399 • Rev. 1977

animal sciences swine

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA 47907

Indiana Station Boar Testing Program

K. J. Drewry, Animal Sciences Department, and L. J. Runnels, DVM,
School of Veterinary Medicine, Purdue University

Purpose of the Program

The Indiana Station Boar Testing Program offers a service to Indiana swine breeders in which central station performance records on boar pigs may be obtained under standardized conditions. The boar pigs will be evaluated at the Indiana Swine Evaluation Station at Purdue University.

In the program, boars are measured for growth rate, feed efficiency, backfat probe, loineye area and visual appraisal; and they are sold at public auction if they meet sales standards.

This program assists the Indiana swine industry in these ways: (1) serving as a partial progeny test for the sire of a test group, (2) acting as a "show window" for the breeder's herd, (3) helping to merchandise desirable breeding stock, and (4) identifying genetically superior seed stock herds for purebred and commercial producers. It also assists the breeder in selection of replacement breeding stock. In addition, it serves to supplement records on progeny from the same herd sire obtained through the Indiana On-Farm Boar and Gilt Testing Programs, the Indiana Swine Progeny Testing Program for market animals, and various breed association testing programs.

Any swine breeder in Indiana may participate in the Boar Testing Program if he can meet the eligibility requirements.

Program Supervision and Direction

Technical supervision and coordination of the program, including operation of the Station, is the responsibility of Purdue University's Animal Sciences Department. The rules and regulations of the program and operation of the Station are the responsibility of the Advisory Committee.

The Advisory Committee shall consist of: (1) two persons from each recognized Indiana swine breed association—each to be elected for a 2-year term; (2) four commercial swine producers—two to be elected or appointed each year by the Indiana Pork Producers Association; (3) the executive vice-president of the Indiana Pork Producers Association; (4) the Swine Evaluation Station manager; (5) the Purdue Extension swine specialist with responsibility of advising on the program; (6) the Purdue veterinarian who serves as Station veterinarian; and (7) the head of the Animal Sciences Department. The latter four are non-voting members on rules and regulations concerning evaluation procedures.

Eligibility

To be eligible, the sow must be owned by an Indiana breeder at farrowing. Boar pigs must be from litters of eight or more pigs at farrowing and have 12 or more prominent, well-spaced nipples. Boars must also be free from inherited defects, such as hernia or cryptorchid (ridgling) condition. Boar pigs will be individually identified by litter and pig number.

Testing Seasons

Fall test shall include those boars farrowed in July and August. These boars are delivered to the Station for start on test between September 1 and November 1. Sales following completion of the test will be held in January and February.

Spring test shall include those boars farrowed in January and February. These pigs are delivered to the Station for start on test between March 1 and May 1. Sales following completion of the test will be held in July and August.

Application

Application forms for consignment of test-groups to upcoming Spring or Fall tests shall be distributed each year in early December and early June. The completed application and entry fee shall be returned by February 1 for the Spring test and by August 1 for the Fall test.

Entry fee: a fee of $100 per pen of two boars is required at time of application for pen space.

Health Requirements

For entry. No pigs will be accepted from premises on which any swine are under state quarantine for any reason. All pigs selected for entry to the Station must have blood drawn, tested and found negative for pseudorabies within 30 days prior to date of delivery.

At delivery. Pigs must be delivered in a clean, disinfected vehicle. They will be examined at delivery and before unloading. Any pig exhibiting signs of disease will be rejected by the Station veterinarian. Upon delivery, pigs will be treated for external and internal parasites, and vaccinated for erysipelas and five strains of leptospirosis.

Pigs entering the Boar Testing Station must be accompanied by a health certificate issued by a licensed, accredited veterinarian certifying that the pigs are free of disease. Examination of the pigs and herd from which they come, pursuant to issuing the health certificate, must be made within 7 days of the entering date.

At time of inspection, the veterinarian and owner must certify on the health certificate that none of the following diseases or conditions are present. *In the herd:* (1) hemorrhagic dysentery (free for previous 365 days), (2) erysipelas, (3) atrophic rhinitis (visible), (4) jowl abcesses, (5) brucellosis, (6) leptospirosis, (7) pseudorabies, and (8) abortions and stillbirths affecting no more than 5 percent of the pigs farrowed. *In the group:* (1) acute or chronic salmonellosis, (2) transmissible gastroenteritis (TGE) (free for previous 60 days), (3) influenza and (4) pneumonia. *In the litter:* myoclonia congenita (shaker pigs, jittery pigs).

Test Group and Pen Assignment

A test group shall consist of two boar pigs from the same sire. These may or may not be from one litter.

Allocation of pens will be made by the Advisory Committee in mid-February for the Spring test and mid-August for the Fall test. Entry fees will be returned for those applications that cannot be accepted. If applications are accepted by the Advisory Committee and test groups are not delivered, the breeder forfeits his entry fee.

Testing Procedure

Testing area. Testing area is a 6-foot x 12-foot pen with solid concrete floor, in an open-fronted building. Pens will be bedded.

Delivery. The test group boar pigs will be delivered to the Station when weights average between 40 and 60 pounds. Test groups with average weights of less than 40 pounds and over 60 pounds will not be accepted.

Initial weights. Boars will be individually weighed and started on test when test group averages 60 pounds, plus or minus 3 pounds.

Intermediate weights. Boars will be weighed individually and feed consumption records obtained at 35 days after going on test. As boars approach 220 pounds, they will be weighed once weekly.

Ration. All boars will be self-fed the same high energy, pelleted, 17% protein corn-soy ration while on test. This is important in identifying the animals with genetic potential for rapid growth. Boars will be self-fed a high fiber, pelleted, 15% protein conditioner ration from completion of test until sale time.

Final weights. Test group boars will be off test for daily gain on the date that the test group average weight reaches or exceeds 220 pounds.

Feed efficiency. Feed efficiency (final) will be calculated for the pen when the group boars average 220 pounds in weight. In case of death or disease loss, average daily feed consumption will be determined by dividing total feed consumption by number of animal days.

Backfat sonoray probe. Each boar will be sonorayed for backfat near time of test completion for daily gain. Backfat probe is the average of three probes taken 2 inches off the midline at the shoulder, back and loin. This average is adjusted to 230 pounds live weight using the NSIF adjustment formula: *Adj. avg. backfat = [((230 – final wt.) x .004) + 1.0] x actual adj. backfat.*

Loineye sonoray. Values will be obtained on each boar near time of test completion. Loineye measurement is adjusted to 230 pounds live weight using the conversion factor of 0.015 inch per pound.

Visual rating. Following completion of gain test, all boars are evaluated individually for structural soundness and underline by a committee of three people: a university person, a purebred breeder and a commercial producer. Boars which the committee rate as unsound for feet and legs, and boars with unacceptable underlines will be ineligible for sale.

Boar Index

Boars will be individually indexed using their test average daily gain, pen feed efficiency and adjusted backfat probe, and the deviation of their records from the test-sale group average for these traits. The point system used in calculating individual boar index is: $100 + 60(DG - \overline{DG}) - 75(FE - \overline{FE}) - 70(BF - \overline{BF})$, where DG, FE and BF are the individual boar records and $\overline{DG}$, $\overline{FE}$ and $\overline{BF}$ are averages for all boars in test-sale group. Average boar index for all boars within a test-sale group will be 100 points. Approximately two-thirds of the boars within a test-sale group will have indexes between 75 and 125 points.

Boar Records and Ratios

Test-sale group averages and individual boar records are reported for daily gain, pen feed efficiency, adjusted backfat and adjusted loineye area. Individual boar ratio values are reported for daily gain, pen feed efficiency and adjusted backfat. These ratio values give the boar's relative superiority to other boars in the test-sale group for these traits.

Health Procedures During Test

The Station veterinarian will oversee the health of the animals at the Station. He will supervise retesting of all boars for pseudorabies approximately 45 days after delivery to the Station. He will consult regularly with the Station manager, the Extension swine specialist serving as program coordinator, and the chairman of the Station Advisory Committee. He is responsible for making recommendations on health and disease problems as well as concerning management practices which affect the health of the animals.

The Station veterinarian will make regular weekly visits to the Station at a time to be agreed upon. All animals will be observed at these regular visits. Other visits will be made when necessary.

Medications are to be administered only by or under the supervision of the Station veterinarian. Drug purchases will be made only on recommendation of the Station veterinarian. An animal shall not be treated individually so as to unfairly influence its performance.

If a particular boar (or boars) becomes ill to the extent that performance can no longer be practically measured, or if in the opinion of the Station veterinarian there is a threat to the other boars as a result of that illness, then the boar (or boars) will be removed from the Station. If there is difference of opinion, a committee consisting of Purdue Large Animal Clinic veterinarians, Advisory Committee officers, Station manager and Animal Science Department personnel will participate in the decision.

If the boar (or boars) dies, the owner will be notified as soon as possible. All boars that die will be necropsied, and a full report made to the owner, Station manager and Extension swine specialist serving as program coordinator.

A health record will be maintained for each boar. Each breeder will be immediately notified if any significant health disturbance occurs among his pigs.

Health Procedures After Test and Before Sale

All boars will be blood tested, found negative to brucellosis and pseudorabies, and will be vaccinated for erysipelas and five strains of leptospirosis within 30 days of the date of sale. Each boar will be inspected for evidence of disease 2 weeks before and again immediately before the sale date.

A separate health certificate shall be issued for each boar. All boars will meet the requirements for interstate shipment as set forth by the Board of Animal Health of the State of Indiana, and the Animal and Plant Health Service of the U.S. Department of Agriculture.

Semen evaluation will be performed at the owner's request.

All health records will be confidential unless released by the owner.

It is recognized that the sale could be cancelled or delayed by an outbreak of an infectious and/or contagious disease. Specific examples are hemorrhagic dysentery, transmissible gastroenteritis and influenza.

Boars will have access to small exercise pens after the test group has completed test.

Sale Standards, Times and Locations

Boars with indexes of 80 or higher will be eligible for sale, provided they meet health, soundness and underline requirements. They will be assigned to a group for sale (40 to 50 boars) according to test completion date.

Two or three sales will be held within each test season, depending on numbers of eligible boars. Sales of Spring-tested boars will be held during July and August; sales of Fall-tested boars in January and February. Location of the sales will be at the Indiana Swine Evaluation Station near Purdue University in West Lafayette.

Withdrawing Sale-Eligible Boars

Boars eligible for sale may be reserved and withdrawn from sale by owner by notifying Station manager prior to printing of the sale catalog and payment of testing expenses. The charge for boars withdrawn prior to printing the sale catalog is $50 plus testing expenses; charge for boars withdrawn after sale catalog printing is $250 plus testing expenses.

Non-Sale-Eligible Boars

All non-sale-eligible boars are taken home by the breeders or marketed after payment of testing expenses, within a 7-day period following notification of sale eligibility.

Testing Expenses

Total testing expenses will be $220 for a group of two boars—$100 pen reservation fee plus $120 testing charge. (Individual boar charges total $110—$50 reservation, $60 testing.)

Sale cost. All sale costs, including advertising, auctioneer, sales pavilion rental, etc., are prorated on a percentage basis for all boars sold.

Refunds to consignors. At the end of each test, each pen entry is credited with income from entry fee and sale of boars. Then testing cost and sale expense are deducted. The difference in income and expense for each pen entry is paid to the consignor.

Reporting of Results

All information on gain and feed efficiency will be sent to each consignor when his pigs have been on test 35 days. All information on gain, feed efficiency, backfat probe and loineye will be sent to the consignor when pigs finish test. Boar index, visual rating and sale eligibility notification will be sent when sale group boars finish test. All information concerning the tests (including season and yearly summaries) is made available to the public.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

AS-57 (Rev.) • 1975

animal sciences sheep

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA 47907

Hoosier Gold Medal Lamb Club Rules and Regulations

J. B. Outhouse and K. J. Drewry, Animal Sciences Department

PURPOSE

The Hoosier Gold Medal Lamb Club program is designed to promote efficient production of fast-gaining, highly-desirable sheep by identifying genetically superior individuals through: (1) records of performance and (2) live animal evaluation.

The Indiana Livestock Breeders' Association will give recognition by awarding certificates to any resident of Indiana who exhibits one or more lambs or pairs of lambs that have qualified by their performance and show ring records (as herein outlined) in the Hoosier Gold Medal Lamb Club.

PARTICIPANTS

Any sheep producer in Indiana who owns an eligible lamb and who purchases an exhibitor's card for each lamb shown, may exhibit in any approved Gold Medal lamb show.

BREEDING OF LAMBS

Ewe and ram lambs must have been sired by registered rams and be from registered ewes of the same breed.

ELIGIBILITY OF LAMBS

Only lambs born in Indiana and owned and exhibited by a resident of Indiana are eligible.

All lambs must have been born between September 1 of the preceeding year and March 31 of the current year to be eligible for Gold Medal lamb shows during the current year. All lambs must be identified with tattoo, ear tag or ear notch.

NOMINATION AND WEIGHT OF LAMBS

Lambs shall be weighed between 70 and 110 days of age in the Indiana Sheep Performance Testing Program. Complete identification of sire, dam and lamb as well as 90-day weight will be reported on Form ISPTP-1, "Indiana Sheep Performance Testing Program-Flock Performance Data." Completion of ISPTP-1 by the owner shall satisfy the nomination requirements for the Hoosier Gold Medal Lamb Club.

Lambs and dams may be identified by flock number or last five digits of the registration number. Sires must be identified by the last five digits of their registration number. Data reported on ISPTP-1 will be verified by the owner's signature.

Completed ISPTP-1 forms must be in the office of the Indiana Sheep Performance Testing Coordinator by June 15 of year of exhibition. Send forms to: Sheep Performance Testing Coordinator, Animal Sciences Department, Purdue University, West Lafayette, Indiana 47907. Lambs may be nominated and qualified free-of-charge to the owner.

QUALIFICATION OF LAMBS

Weight of lambs will be adjusted to 90-day basis. The 90-day adjusted weight will include adjustments for age of lamb, age of dam, sex of lamb, type of birth and type of rearing of lamb. The adjustment factors used are presented in Table 1.

The average adjusted 90-day weight for each sex will be calculated for each flock. Each lamb's adjusted 90-day weight will be expressed as a deviation from the average flock-sex adjusted 90-day weight as shown in Table 1.

Any ewe or ram lamb with a 90-day adjusted weight and which meets the breeding, age and lambing date requirements, will be eligible for exhibition in Hoosier Gold Medal shows, provided the owner obtains an exhibitor's card from the Indiana Livestock Breeders' Association as outlined below.

If a lamb is sold before being weighed and qualified, it is the responsibility of the new owner to weigh the lamb between 70 and 110 days of age,

Table 1. *Indiana Sheep Performance Testing Program Adjustment Factors.* *

	Age of Dam		
Factor	1 year old	2 years old, or over 6 years old	3 to 6 years old
Ewe Lamb			
Single raised as single	1.22	1.09	1.00
Single raised as twin	1.33	1.20	1.11
Twin raised as twin	1.33	1.20	1.11
Twin raised as single	1.28	1.14	1.05
Triplet raised as triplet	1.46	1.33	1.22
Triplet raised as twin	1.42	1.28	1.17
Triplet raised as single	1.36	1.21	1.11
Wether			
Single raised as single	1.19	1.06	.97
Single raised as twin	1.30	1.17	1.08
Twin raised as twin	1.30	1.17	1.08
Twin raised as single	1.25	1.11	1.02
Triplet raised as triplet	1.43	1.30	1.19
Triplet raised as twin	1.39	1.25	1.14
Triplet raised as single	1.33	1.18	1.08
Ram Lamb			
Single raised as single	1.11	.98	.89
Single raised as twin	1.22	1.09	1.00
Twin raised as twin	1.22	1.09	1.00
Twin raised as single	1.17	1.03	.94
Triplet raised as triplet	1.35	1.22	1.11
Triplet raised as twin	1.31	1.17	1.06
Triplet raised as single	1.25	1.10	1.00

*Example: To find *adjusted 90-day weight and adjusted 90-day weight ratio* of a single born and reared ram lamb from a 4-year-old ewe that weighed 75 pounds at 87 days of age, when all ram lambs in flock have an adjusted 90-day weight of 66 pounds, make the following calculations:

(1) WPDA = 75 lbs./87 days = 0.862 lbs./day
(2) Act. 90-day wt. = 0.862 lbs/day x 90 days = 77.6 lbs. = 78 lbs.
(3) Adj. 90-day wt. = 77.6 lbs. x 0.89 (adjustment factor)
= 69.1 lbs. = 69 lbs.
(4) Adj. 90-day wt. ratio = 69 lbs/66 lbs. (ram lamb average)
= 104.5 or 105

complete Form ISPTP-1 and forward same to the Indiana Sheep Performance Testing Coordinator by June 15 of the year of exhibition.

Lambs qualified in other recognized sheep performance testing programs may qualify for the Hoosier Gold Medal Lamb Club by meeting the requirements outlined above. Eligibility will be dependent upon receipt of a verified copy of the official performance record of said lambs by the Indiana Sheep Performance Testing Coordinator by June 15 of the year of exhibition.

OBTAINING EXHIBITOR'S CARDS

Owners of qualified lambs must designate by June 15 those lambs for which they wish an official exhibitor's card prepared. These cards can be obtained from the Secretary of the Indiana Livestock Breeders' Association at a cost of $1.00 each and entitle the owner to exhibit in any Gold Medal show.

TRANSFER OF QUALIFIED LAMBS

If lambs already qualified for Gold Medal exhibition are sold, the original owner must enter the new owner's name and address on the official exhibitor's card and forward it to the new owner.

The new owner of a lamb already qualified for Gold Medal exhibition need not reweigh or requalify the lamb, since the official exhibitor's card remains with the lamb.

SHOWING OF LAMBS

Any qualified lamb having an official exhibitor's card is eligible for exhibition in any approved Gold Medal show. Lambs whose owners are not able to present the official exhibitor's card certifying eligibility will not be admitted to Gold Medal classes.

The exhibitor's name on the Gold Medal show report must be exactly the same as the owner's name on the official exhibitor's card. Willful exhibition of any animal by a person or firm other than the bonafide owner(s) will result in disqualification for awards for said animal and forfeit of all awards by owner.

Classes at approved Gold Medal shows will be as follows:

1. Single ewe lambs.
2. Single ram lambs.
3. Pair (two) ewe lambs.
4. Pair (two) ram lambs.

The single ewe and ram classes may be divided by age into fall and spring classes at the discretion of the show committee. The pair of ewe lambs and pair of ram lambs may or may not be sired by the same ram. However, both lambs in a pair must be sired by the same ram for point consideration in determining the Ram-of-the-Year award (Quakenbush trophy).

The show management or committee in charge, at approved county, area or state Gold Medal shows, shall arrange Gold Medal classes for all breeds if the show records are to be used in determining Ram-of-the-Year awards.

SHOW REPORTS

All Gold Medal show reports must be forwarded to the secretary of the Indiana Livestock Breeders Association on or before September 15. The show report must indicate:

1. Name of the show.
2. Total number in each class.
3. Placing of each animal.

4. Name and address of exhibitor.

5. Flock code, identification number, sex, date of birth, adjusted 90-day weight and sire's registration number of each lamb shown.

BASIS OF AWARDS

There shall be at least two exhibitors in each Gold Medal class. In Gold Medal classes, awards (G, gold; S, silver and B, bronze) will be as shown in Table 2.

Awards shall be made on the basis of Gold Medal show reports of lambs as herein provided; but no award will be made unless all requirements set forth under nomination, qualification and exhibition are complied with.

Awards will be made by the exective committee of the Indiana Livestock Breeders' Association under the conditions outlined herein.

LIMITATION OF AWARDS

Each exhibitor in Gold Medal classes is limited to two awards in single lamb and pair-of-lamb classes. In classes where the exhibitor furnishes his own competition, only a bronze award will be made.

RAM-OF-THE-YEAR AWARD

The Quakenbush trophy will be awarded to the owner of the ram (sire) whose progeny earn the most points in any one year at county and/or area Gold Medal shows and the Indiana State Fair Gold Medal show.

Rams are awarded points based on the placings of their progeny at: (1) the highest two county and/or area Gold Medal shows, and (2) the Indiana State Fair Gold Medal Show, as shown in Table 3.

Table 2. *Gold Medal Class Awards.*

No. in class	Placing											
	1	2	3	4	5	6	7	8	9	10	11	12
2	B											
3	S	B										
4	G	S	B									
5	G	S	B									
6	G	S	B	B								
7	G	S	S	B	B							
8	G	G	S	S	B	B						
9	G	G	S	S	B	B						
10	G	G	S	S	B	B	B					
11	G	G	S	S	S	B	B	B				
12	G	G	G	S	S	S	B	B	B			
13	G	G	G	S	S	S	B	B	B			
14	G	G	G	S	S	S	B	B	B	B		
15	G	G	G	S	S	S	S	B	B	B	B	
16	G	G	G	G	S	S	S	S	B	B	B	B

Table 3. *Ram-of-the-Year Award Point System.*

	County-area show		State Fair	
Award	Indiv.	Pair*	Indiv.	Pair*
Gold	40	60	80	120
Silver	20	30	40	60
Bronze	10	15	20	30

*Same Sire

Additional points will be credited to the sire if both lambs in a pair are sired by the same ram as shown in Table 3. These additional points are credited to the sire regardless of ownership of the lambs exhibited.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

FORWARD THIS TO:
SHEEP EXTENSION SE.
ANIMAL SCIENCES DEPARTMENT
LILLY HALL, PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

INDIANA SHEEP PERFORMANCE TESTING GRAM – Flock Performance Data

Indiana Cooperative Extension Service, Purdue University

-1 (REV 1-74)

COUNTY______________ OWNER______________ ADDRESS______________ RR ______ CITY ______ ZIP CODE

FLOCK CODE _ _ _ _ _ (1-5) TYPE OF FLOCK ___ (6) I, ______________ (OWNER'S SIGNATURE). CERTIFY THAT THE RECORDS SHOWN HERE ARE CORRECT.

	EWE RECORD					RAM RECORD			LAMB RECORD											
									BIRTH RECORDS				90-DAY RECORDS							
										BIRTH DATE					DATE WEIGHED					
LAMB NO	NO.	CLASS	BREED	AGE	WOOL WEIGHT	REG. NO.	CLASS	BREED	BIRTH CODE	MO.	DAY	YEAR	SEX	REARING CODE	MO.	DAY	YEAR	WEIGHT	CODED REMARKS	FOSTER EWE NO.
7-11	12-16	18	19-20	21-22	23-25	29-33	35	36-37	39	40-41	42-43	44-45	49	50	52-53	54-55	56-57	58-60	72-74	75-79

EXPLANATION OF ITEMS

FLOCK CODE is assigned by State Office.

ANIMAL IDENTIFICATION is limited to 5 digits. Use flock tag for lambs, ewes and grade rams. Use last 5 digits of Reg. No. for registered rams.

AGE OF EWES (in Years) is recorded at birth of lamb(s) being tested. If not known, record as 5 years.

90-DAY WEIGHT is obtained between 70 and 110 days. Use suggested weigh schedule below left. Weigh all lambs.

210-DAY WEIGHT is obtained between 180 and 240 days. Use suggested weigh schedule below right. Weigh all replacement and sale ewes and rams.

WOOL WEIGHT, CODED REMARKS, FOSTER EWE NO. completion of these shaded columns is optional.

COMPLETION INSTRUCTIONS

Be neat when completing this form ISPTP-1.

Use leading zeros on dates and weights (e.g., Feb. 9, 1974 is 02/09/74, or 65 lbs. is 065).

Forward completed 90-Day Record (white copy) for your 90-day summary. (Gold Medal participants may wish to have 90-day weight records of fall and spring lambs summarized separately).

Forward completed 210-Day Record (yellow copy) for your 210-day summary.

Summaries of 90- and 210 Day Records will be returned within 10 to 14 days after being received by State Office.

Retain Owner's (pink) copy for your files.

90 DAY RECORDS

SUGGESTED WEIGH SCHEDULE — 90 DAY WEIGHTS

NON-LEAP YEAR LAMBING DATE	WEIGH DATE
1/1 - 2/10	4/21
2/11 - 3/23	6/1
3/24 - 5/3	7/12
5/4 - 6/13	8/22
6/14 - 7/24	10/2
7/25 - 9/3	11/12
9/4 - 10/14	12/23
10/15 - 11/24	2/2
11/25 - 1/4	3/15*

* ONE DAY EARLIER IF IN LEAP YEAR

LEAP YEAR LAMBING DATE	WEIGH DATE
1/1 - 2/10	4/20
2/11 - 3/22	5/31
3/23 - 5/2	7/11
5/3 - 6/12	8/21
6/13 - 7/23	10/1
7/24 - 9/2	11/11
9/3 - 10/13	12/22
10/14 - 11/23	2/1
11/24 - 1/3	3/14

TYPE OF FLOCK
- 1 - Registered
- 2 - Registered and Commercial
- 3 - Commercial

CLASS CODE
- 0 - Registered
- 1 - Grade
- 2 - Crossbred

SEX CODE
- 1 - Ram
- 2 - Ewe
- 3 - Wether

BIRTH CODE
- 0 - No lambs
- 1 - Single
- 2 - Twin
- 3 - Triplet
- 4 - Quadruplet

REARING CODE
- 1 - Single, reared as single
- 2 - Single, reared as twin
- 3 - Twin, reared as twin
- 4 - Twin, reared as single
- 5 - Triplet, reared as triplet
- 6 - Triplet, reared as twin
- 7 - Triplet, reared as single
- 8 - Lamb not weighed

BREED CODES
- 11 - Debouillet
- 12 - Delaine Merino
- 13 - Merino
- 14 - Rambouillet
- 30 - Cheviot
- 31 - Corriedale
- 32 - Dorset
- 33 - Hampshire
- 34 - Oxford
- 35 - Ryeland
- 36 - Shropshire
- 37 - Southdown
- 38 - Suffolk
- 39 - Tunis
- 50 - Columbia
- 51 - Montadale
- 52 - Panama
- 53 - Romeldale
- 54 - Southdale
- 55 - Targhee
- 70 - Border Leicester
- 71 - Cotswold
- 72 - Finnish Landrace
- 73 - Leicester
- 74 - Lincoln
- 75 - Scottish Blackface
- 76 - Navajo

SUGGESTED WEIGH SCHEDULE — 210 DAY WEIGHTS

NON-LEAP YEAR LAMBING DATE	WEIGH DATE
1/1 - 3/2	8/29
3/3 - 5/2	10/29
5/3 - 7/2	12/29
7/3 - 9/1	2/28
9/2 - 11/1	[illegible]
11/2 - 1/1	6/30*

* ONE DAY EARLIER IF IN LEAP YEARS

LEAP YEAR LAMBING DATE	WEIGH DATE
1/1 - 3/1	8/28
3/2 - 5/1	10/28
5/2 - 7/1	12/28
7/2 - 8/31	2/27
[illegible]	[illegible]
11/1 - 12/31	[illegible]

LESSON 5: SELECTION OF MEAT TYPE ANIMALS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Identify the parts of a beef animal.
2. Determine if the parts of a hog are labeled correctly on a diagram and correct any errors.
3. Locate and write in the parts of a lamb on a diagram.
4. List the wholesale cuts of beef, swine, and sheep on corresponding diagrams.
5. Recognize high quality vs a low quality meat animal.
6. List terms that describe various strengths and weaknesses in terms of animals side, rear, and front view.
7. Judge and place market classes giving reasons for the placings.

MOTIVATION:

A beginning agriculture student told his agriculture teacher that he had placed the class of steers 4-3-1-2. The teacher asked him why he had placed the steers in this order. The student said, "Well, I thought 4 looked the nicest and 2 the worst and three looked a little nicer than 1." Do you think this was a good answer. Do you have any idea what the class looked like? How might the student improve his answer?

During this lesson schedule a tour of a packing plant.

REFERENCES:

"Livestock Judging and Evaluation", Purdue University, AS 388

Handouts: "Which Steer Do you Think is Best?"
(See also, comparison of steers transparencies)

Transparency Masters: "Parts of a Beef Animal"
"Parts of a Hog"
"Wholesale Cuts of Beef"
"Wholesale Cuts of Pork"
"Ideal Beef Conformation"
"Ideal Swine Conformation"
"Comparison of Correct with Defective Front Legs"
"Comparison of Correct with Defective Hind Legs"
"Substance of Bone and Set of Legs and Feet"

"Comparison of Live Steers (Side View)"
"Comparison of Steer Carcasses (Side View)"
"Comparison of Live Steers (Front View)"
"Cross Section of Steer Carcasses (Front View)"
"Comparison of Live Steers (Rear View)"
"Cross Section of Steer Carcasses (Rear View)"

OUTLINE:

A. Parts of a Beef Animal: (see transparency)

B. Parts of a Hog: (see transparency)

C. Wholesale Cuts of Beef Carcass: (see transparency)

D. Wholesale Cuts of Pork: (see transparency)

E. Ideal Beef Animal: (see transparency)

F. Beef Conformation: (side view)

1. Large, fast growing
2. Balanced and symmetrical
3. Adequate depth of body
4. Length in the loin and rump
5. Straight topline
6. Underline should be trim, especially in the rear flank, cod and brisket areas
7. Evidence of a large volume of long, loose muscling in the forearm, loin, and stifle area
8. Correct and sound on feet and legs
9. Upheaded and stylish

G. Beef Conformation: (rear view)

1. Carries thickness front to rear
2. Shows evidence of muscling down the top
3. Trim middle

4. Level rump - wide pin placement
5. Deep, wide, muscular quarters
6. Legs set out on the corners of the body

H. Beef Conformation: (front view)

1. A growthy, youthful head, and a wide muzzle
2. Shows width of chest and chest floor
3. A large, long prominent forearm
4. Correctly set at the front legs
5. Clean and free of leather through the throat and brisket

I. Common faults in Conformation (side view):

1. Undersized
2. Lacking balance
3. Too shallow to too deep sided
4. Short coupled
5. Filled with fat in the flank, cod, and brisket regions
6. Lack of muscle expression
7. Incorrect on feet and legs
8. Light muscled
9. Lacking style

J. Common faults in Conformation (rear view):

1. Narrow bodied
2. Lack of muscle expression in the rump, round, and stifle
3. Paunchy
4. Sloping rump
5. Incorrectness on feet and legs

K. Common faults in Conformation (front view):

1. Short, square early maturing head

2. Large, wasty brisket

3. Narrow chest

4. Incorrect on feet and legs

L. Swine Conformation Characteristics:

1. "Coke bottle effect" viewed from the top.

   a. greatest thickness at stifle and flared ham
   b. long bodied
   c. clean shoulder, free moving

2. From side view:

   a. trim jowled
   b. short neck
   c. long, smooth sided (stretchy)
   d. hooks up high in the ham
   e. arch to the rump, loin, and back
   f. clean underline
   h. strong pasterns
   i. six well placed teats on each side for breeding stock

3. Front view:

   a. wide chest floor
   b. clean alert head
   c. head showing breed and sex character
   d. square standing, heavy boned
   e. correct in set to feet and legs

M. Sheep Conformation:

1. Head:

   a. bold-faced
   b. more open-faced
   c. feminine head (ewes), stronger head (rams) (both)
   d. breedier headed (breeding)
   e. shows breed type and sex character about the head and ear (breeding)

2. Fore Quarters:

   a. Neck blends in smoothly to shoulder
   b. Wide chested, bold fronted ram
   c. Prominent muscling through forearm
   d. Well-sprung forerib
   e. Muscling through the shoulder and down into the arm and forearm region

3. Ribs, back and loin terms:
    a. Thicker, meatier, heavier muscled loin
    b. Strong back
    c. Firm topped
    d. Clean underline

4. Rump and leg terms:
    a. Longer rumped
    b. Thicker more bulging leg
    c. Deeper, plumper leg
    d. More meatiness and muscling in the leg
    e. Bulging, muscular stifle
    f. Harder, firmer, trimmer about the base of the leg and through the crotch

5. Feet, legs, and bone terms:
    a. Heavier boned, squarer standing
    b. Bigger, stouter, longer legged, more upstanding
    c. Rugged boned ram
    d. Soundest feet and legs
    e. Strong pasterns

6. Finish terms:
    a. Uniformly covered
    b. Trim fronted
    c. Evenly distributed finish

7. Fleece, wool and skin terms:
    a. longer denser fleece
    b. highest quality
    c. fleece with character (crimp)
    d. bright, clean fleece

N. Common faults in Sheep Conformation

1. Head:
    a. roman nose
    b. coarse heavy ear
    c. wool blind
    d. coarse-headed

2. Fore quarters:
    a. long necked ewe
    b. u-necked
    c. too sharp over the shoulders
    d. narrow at shoulders
    e. pinched in the fore rib

3. Ribs, back and loin terms:
    - a. shallow ribs
    - b. fish-backed (narrow topped)
    - c. pinched in the loin
    - d. slack framed, light muscled

4. Rump and leg:
    - a. short legged
    - b. light boned
    - c. weak on legs
    - d. lacks strength in pasterns
    - e. sickle hocked
    - f. cow hocked
    - g. knock kneed
    - h. unsound feet and legs

TEACHING LEARNING ACTIVITIES:

1. Why is it necessary to know the major parts of a meat animal? Discuss the importance. Show the transparencies on parts of the animals.

2. Take off the transparencies and hand out an incorrectly labeled hog or beef diagram. Have each student correct the errors and hand in. Put the hog parts transparency back on and review the parts and where the errors were located in the handout diagram.

3. Give each student a blank diagram of a sheep. Have each student fill in the parts of a sheep on their diagram.

4. Which of the cuts mentioned in the transparencies of carcasses do you feel are most important? Why? What effect might this have when you select livestock. Show parts of a sheep carcass.

5. A field trip to the local butcher or packer would help explain the importance of certain cuts. Show the class the areas for loin eye measurement and locate the bone and first rib for carcass measurement and measure the carcass.

6. Have the students study the transparency, "Ideal Beef Conformation", in detail. Emphasize to the student that it is necessary to have this ideal in mind at all times when evaluating cattle.

7. Discuss some of the ideal conformation terms and some of the common faults to look for when selecting meat animals.

8. Ask students if they've seen many animals that look like the "ideal types" on their way home from school.

9. When viewing the ideal steer from the rear, what should be the widest part of the calf?

10. Select some students to stand up front facing the class and show a comparison of correct with defective front legs, and ask the students seated if their classmates are splay footed, toed in or are they correct? Note that this is also something to view when selecting breeding stock.

11. Which of the following defects can be seen most often from the transparency, "Comparisons of Correct with Defective Hind Legs."

12. Are correct feet and legs economically more important on breeding animals or meat animals? Why? Show the transparency, "Substance of Bone and Set of Legs and Feet."

13. After reviewing the transparencies on the live steers, ask students if they really see the difference between an almost ideal and less than ideal steer? Why are these differences so important?

14. Take students on a local field trip to judge cattle. Have students place a class of beef animals or sheep and make notes of reasons why. Have students study the terminology and revise their judging notes with the correct terms.

15. Have students judge a market swine class. Have a person who regularly judges swine give a demonstration of placing the class and giving reasons.

16. For further livestock selection practice, take interested students to invitational livestock judging contests.

SUGGESTED EVALUATION:

1. Take a test judging trip and have students judge a class of meat animals. Take up their placings for grading.

2. Allow each student to write his placing down and have each student write out the reasons why the class was placed in the selected order.

3. Assign grades to class projects.

Information for Transparencies on Steer Comparisons

WHICH STEER DO YOU THINK IS BEST?

(See if you agree with the following)

SIDE VIEW:

Steer number 1 is a tall, narrow, shallow bodied steer lacking in balance and quality, exhibiting a lack of substance of bone and overall finish. Number 1 would be a slow grower and late finisher in the feedlot with little muscling resulting in an excessively finished, light muscled carcass.

Steer number 2 more nearly approaches the ideal animal that is bigger, stouter, stretchier, and heavier muscled. Standing on more substance of bone. Number 2 exhibits a muscular full loin and a deep bulging rear quarter. He has length and is level from hooks to pins. 2 indicates the type of steer that is a fast, efficient converter of feed to red meat.

Steer number 3 is a low set, short bodied, old fashioned steer. A steer that is fineboned, light muscled, and over-finished showing excess fat in the throat, brisket, flanks, and about the tail head. Steers of this type exhibit lower weaning weights, makes slower gains, and utilizes feed less efficiently.

CARCASS SIDE VIEW:

Comparing the carcasses of these three steers from the side view:

Steer number 1 shows a lack of muscling, is a light framed steer; and would yield a lower percent of high quality retail cuts.

Steer number 2 exhibits desirable length of body with a long, level loin and rump; shows evidence of heavy muscling through the shoulder, loin, and rear quarter with a deep bulging round, carried the correct amount of finish; and would cut out a high percent of the primal cuts (loin, rib, round, and chuck).

Steer number 3 demonstrates an unbalanced, heavy-fronted, carcass that is too short of body and is wasty in the brisket, middle, and flanks; lacks desirable muscling; is light in the hindquarter; is over finished; and therefore, will yield an over-finished, wasty, light muscled carcass.

THE FRONT VIEW:

Steer number 1 lacks substance of bone and scale; is narrow through the shoulder and in the chest floor; he is a slab sided, narrow bodied steer which would only put on waste if left in the feed lot, and would not have the width or depth for additional muscling required for a top quality steer.

Steer number 2 exhibits a wide clean front, is well muscled through the forearm, and stands squarely on a sound foundation. He is a big framed steer with lots of room to put on the muscling that a fast gaining, efficient feed converter should have.

Steer number 3 is extremely wasty; a low set, thick, smooth animal lacking size, scale, and muscling. The excess flab is evident in the brisket and through the shoulders and over the back. This steer shows evidence of light muscling and would finish out at a light weight putting on inefficient gains by adding fat.

BRISKET CROSS SECTION VIEW:

Steer number 1, a narrow bodied steer, shows light muscling which decreases the amount of meat or muscling that the animal could produce. A small amount of marbling would indicate drier less tasty meat.

Steer number 2 is a correctly finished carcass that is trim and heavy muscled which will cut out a high percent of red meat.

Steer number 3 is an over-finshed, wasty undesirable carcass, showing excess fat in the brisket and a minimum of muscling throughout.

THE REAR VIEW:

Steer number 1 is light framed, and narrow in the quarter showing little evidence of muscle expression through the stifle; any additional weight on this steer would go to fat. Compare the body shapes of Steer 1 and Steer 3, which is also light muscled but over-finished.

Steer number 2 is a heavy framed upstanding steer that is extremely heavy muscled through the rear quarter showing correct muscle development through the round and free of excess finish in the twist indicating an efficient converter of grain to beef.

Steer number 3 is a short, light muscled, flat backed, over fat animal showing excess fat about the tail head and through the quarter, and would not exhibit the qualities of gains and feed efficiency as Steer 2.

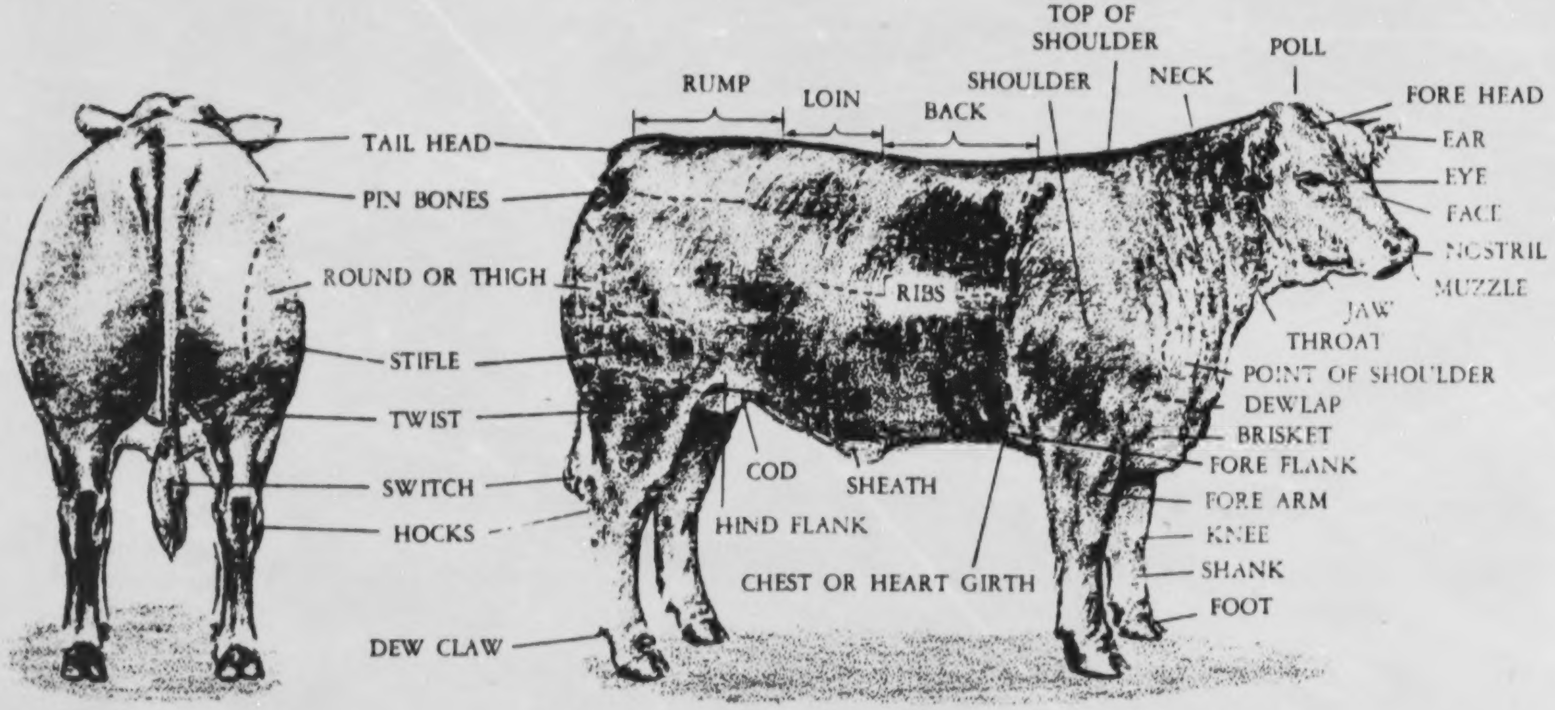
THE ROUND CROSS SECTION VIEW

Steer number 1 shows light muscling through the round, lacks finish, and is very narrow framed which decreases the amount of high priced cuts that a wider framed heavier muscled steer can produce.

Steer number 2, a heavy muscled, correctly finished steer showing thickness through the round with the size to yield a large amount of high quality beef.

Steer number 3 exhibits excessive amounts of fat over the top and at the cushion of the round, is light muscled and will yield an overall wasty undesirable carcass.

PARTS OF A BEEF ANIMAL


TOP OF SHOULDER
POLL
RUMP
LOIN
BACK
SHOULDER
NECK
FORE HEAD
TAIL HEAD
EAR
EYE
PIN BONES
FACE
NOSTRIL
ROUND OR THIGH
RIBS
MUZZLE
JAW
THROAT
STIFLE
POINT OF SHOULDER
DEWLAP
TWIST
BRISKET
FORE FLANK
COD
SHEATH
SWITCH
FORE ARM
HOCKS
HIND FLANK
KNEE
SHANK
CHEST OR HEART GIRTH
FOOT
DEW CLAW

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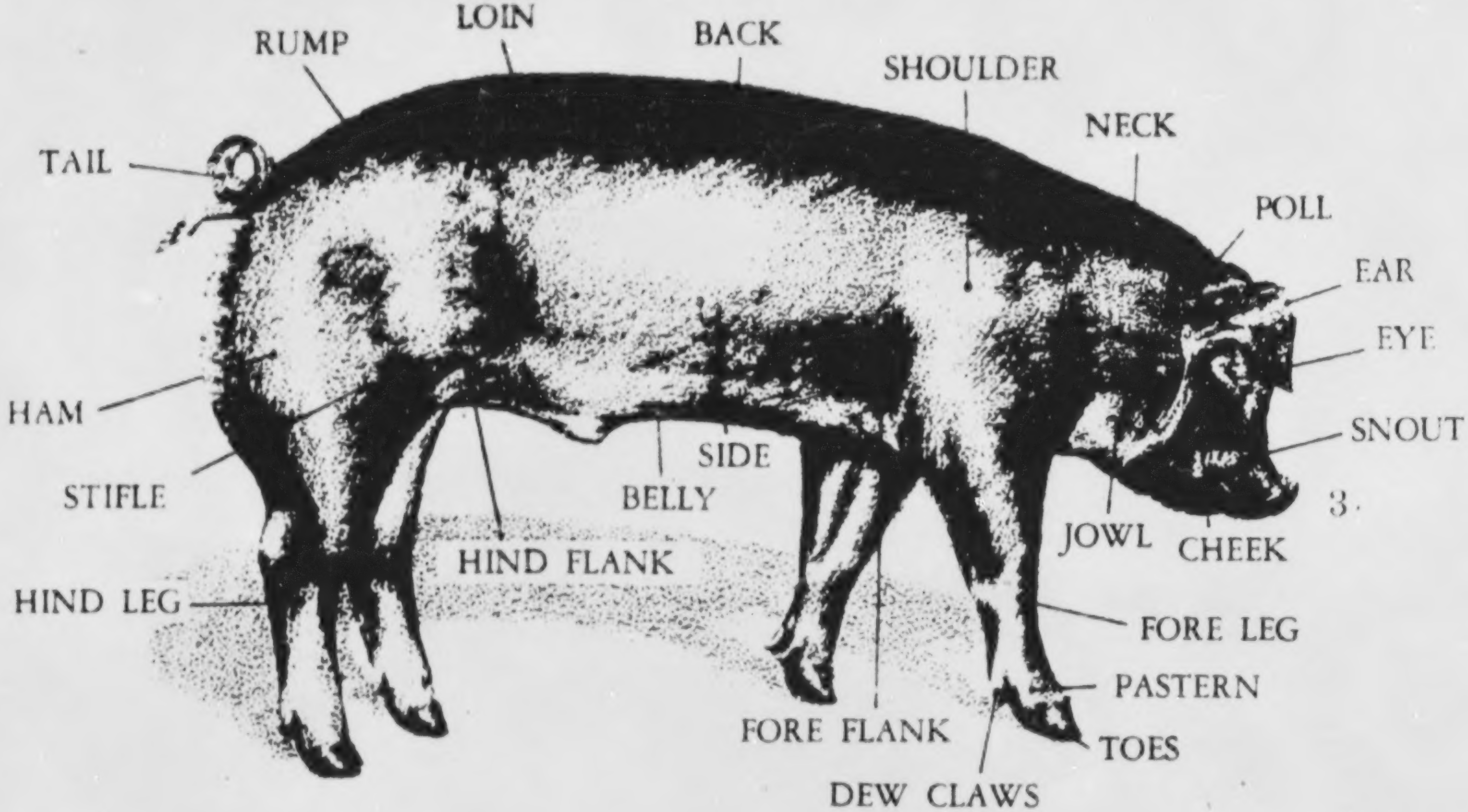
PARTS OF A HOG


LOIN
RUMP
BACK
SHOULDER
TAIL
NECK
POLL
EAR
EYE
HAM
SNOUT
SIDE
STIFLE
BELLY
3.
JOWL
CHEEK
HIND FLANK
HIND LEG
FORE LEG
PASTERN
FORE FLANK
TOES
DEW CLAWS

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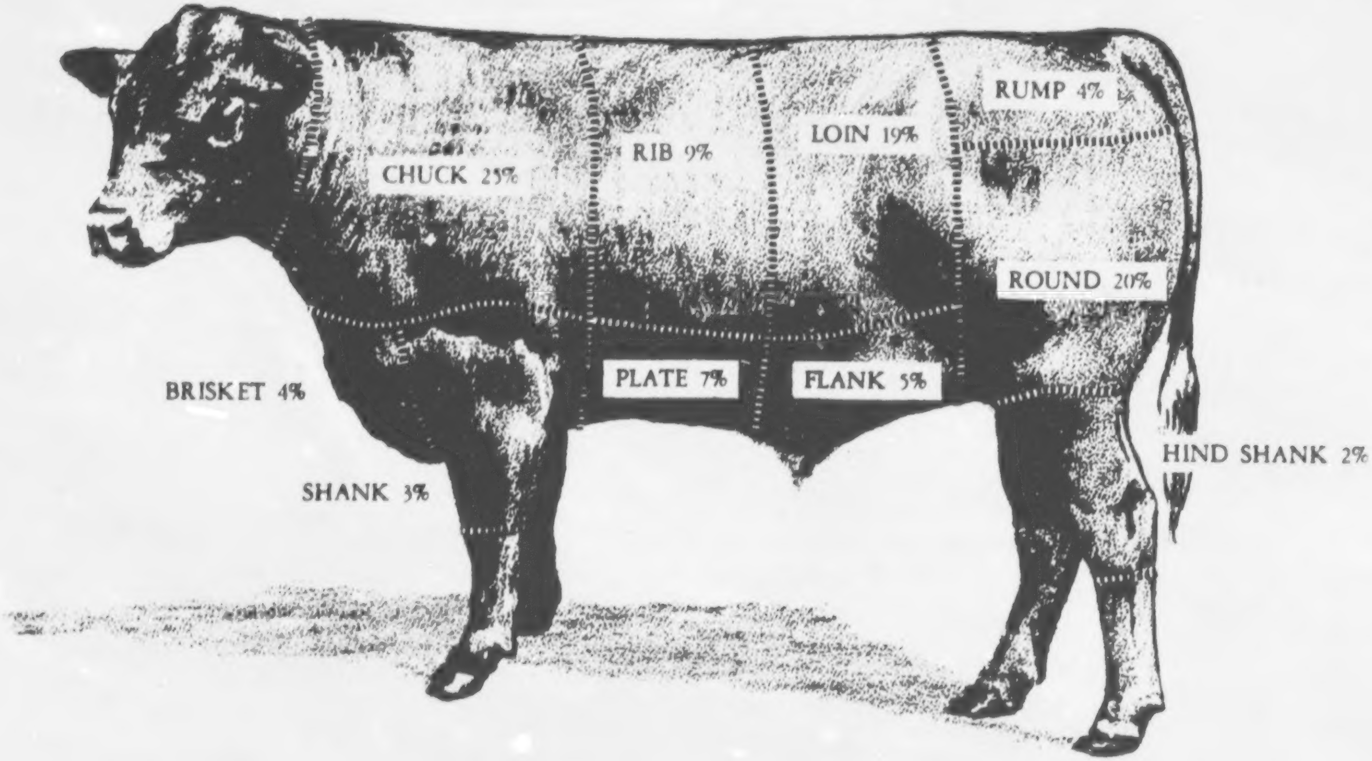
College Station, Texas 77843

VI-50 T

WHOLESALE CUTS OF BEEF


RUMP 4%
LOIN 19%
RIB 9%
CHUCK 25%
ROUND 20%
PLATE 7%
FLANK 5%
BRISKET 4%
HIND SHANK 2%
SHANK 3%

VI-51 T

Courtesy of Vocational Instructional Services
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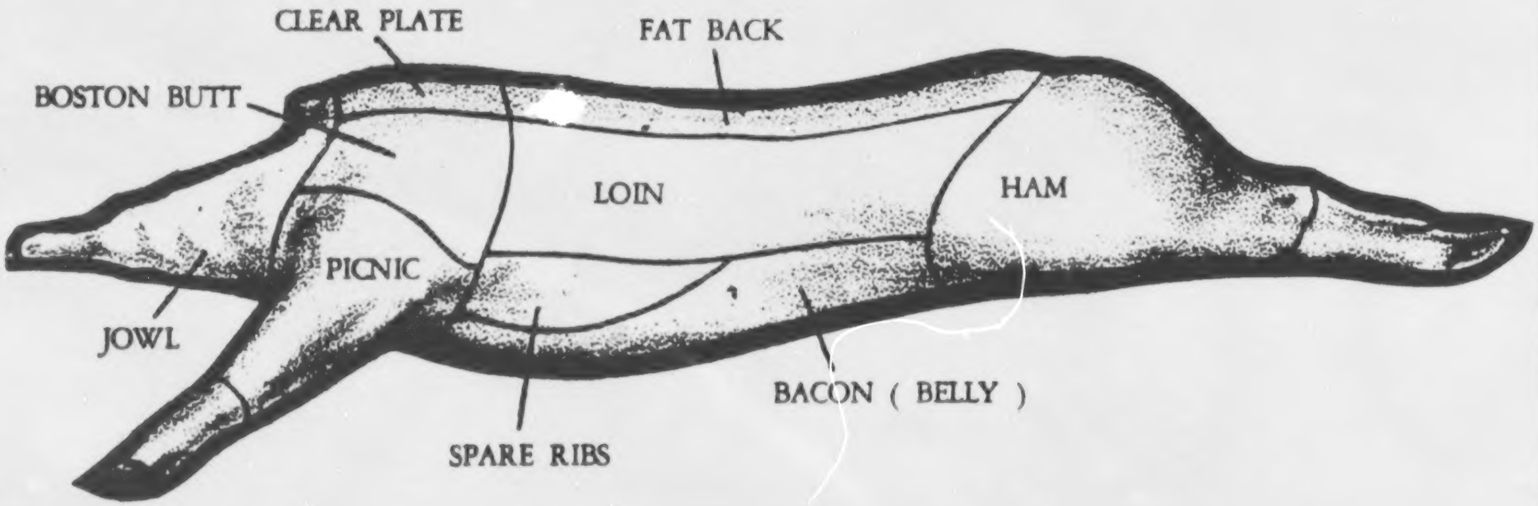
WHOLESALE CUTS OF PORK


CLEAR PLATE
FAT BACK
BOSTON BUTT
LOIN
HAM
PICNIC
JOWL
BACON (BELLY)
SPARE RIBS

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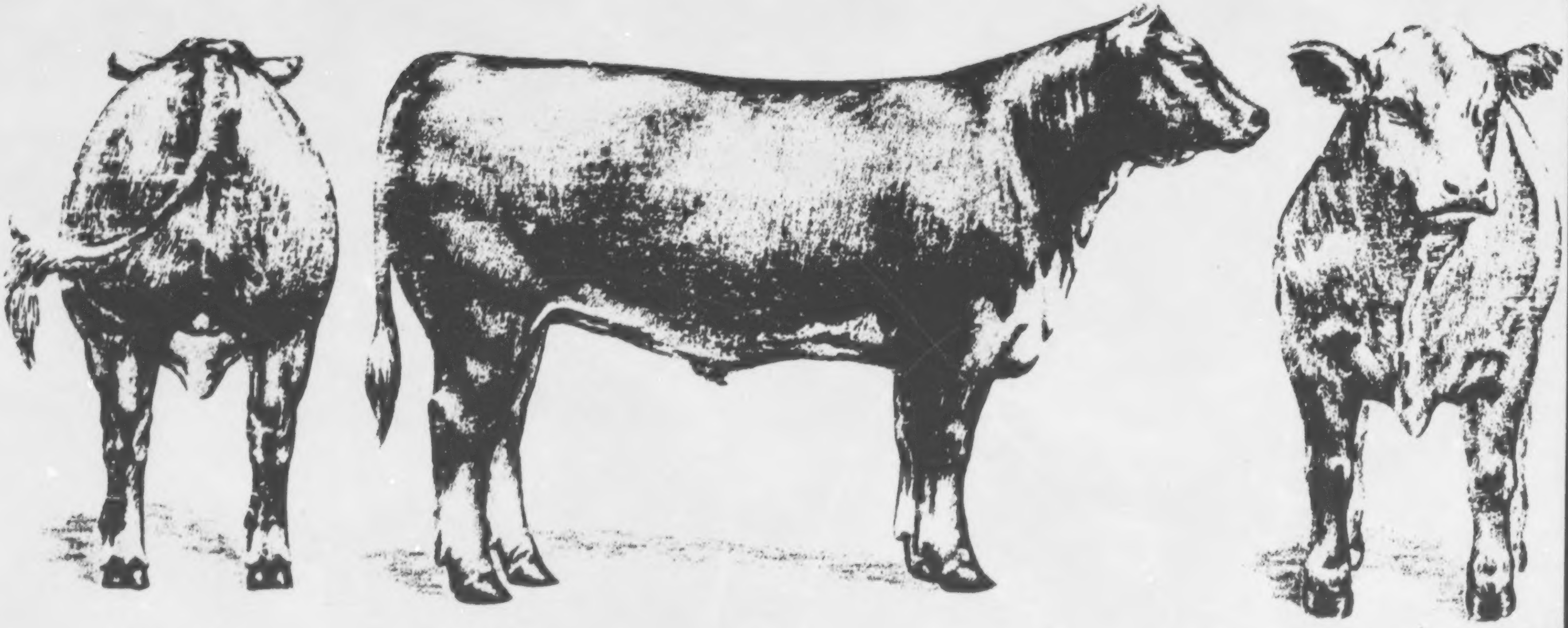
IDEAL BEEF CONFORMATION



REAR VIEW

SIDE VIEW

FRONT VIEW

VI-53 T

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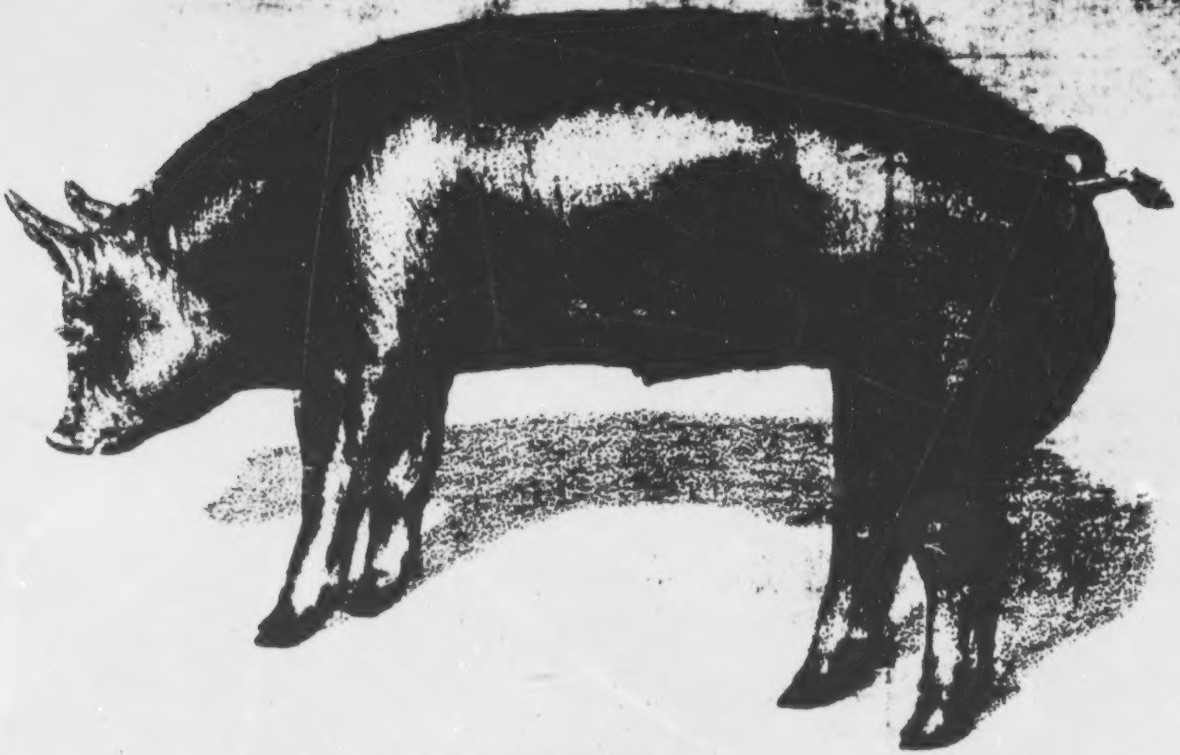
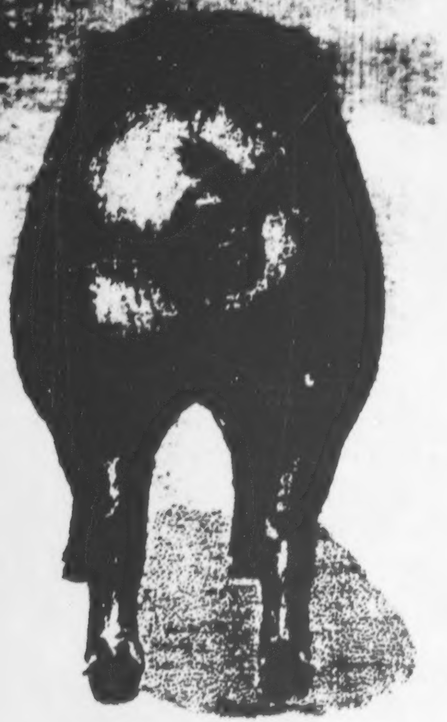
CONF[illegible]



SIDE VIEW



REAR VIEW

VI-54 T

Courtesy of Texas Instructional Services
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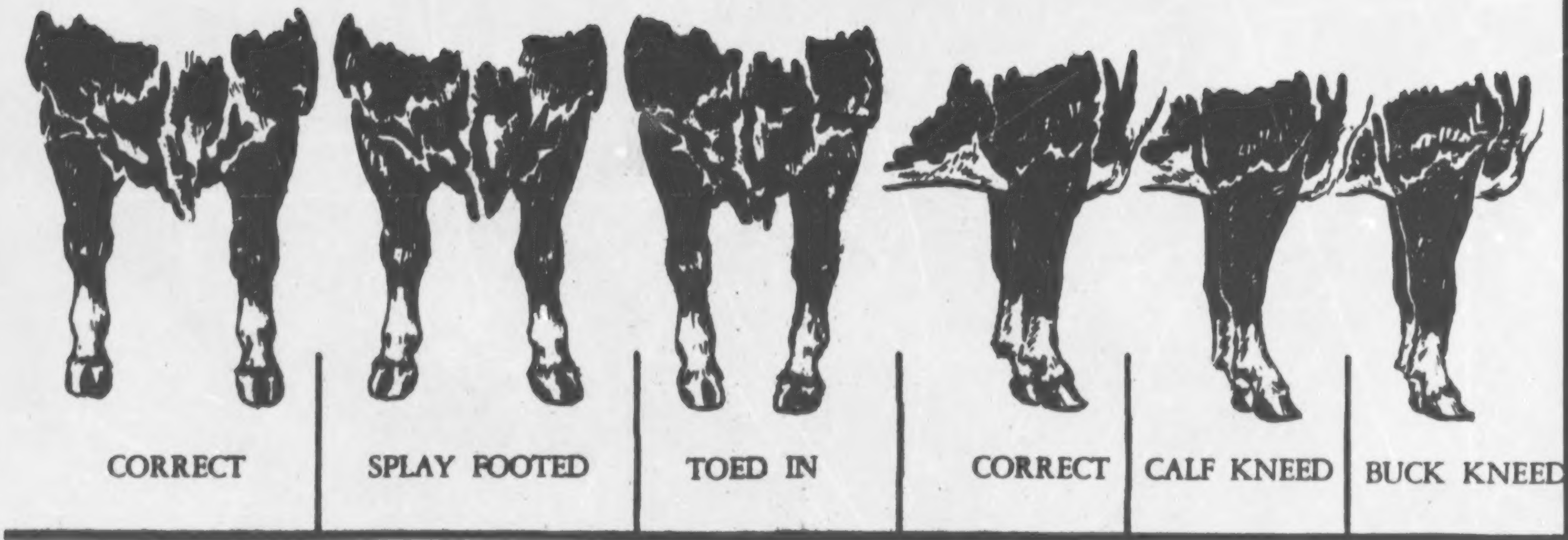
COMPARISON OF CORRECT WITH DEFECTIVE FRONT LEGS


CORRECT
SPLAY FOOTED
TOED IN
CORRECT
CALF KNEED
BUCK KNEED

Courtesy of Vocational Instructional Services
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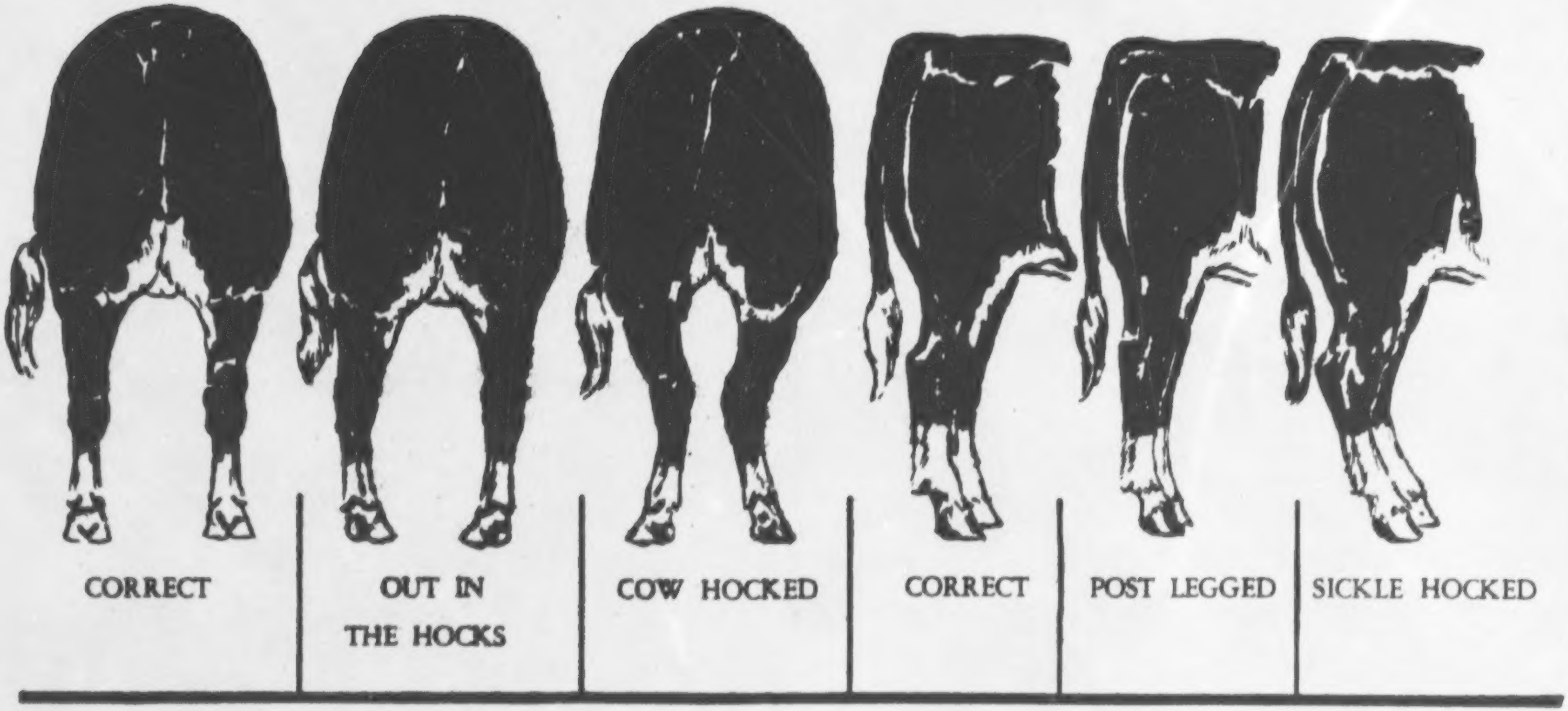
VI-55 T

COMPARISON OF CORRECT WITH DEFECTIVE HIND LEGS


CORRECT
OUT IN THE HOCKS
COW HOCKED
CORRECT
POST LEGGED
SICKLE HOCKED

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VI-56 T

SUBSTANCE OF BONE AND SET OF LEGS AND FEET

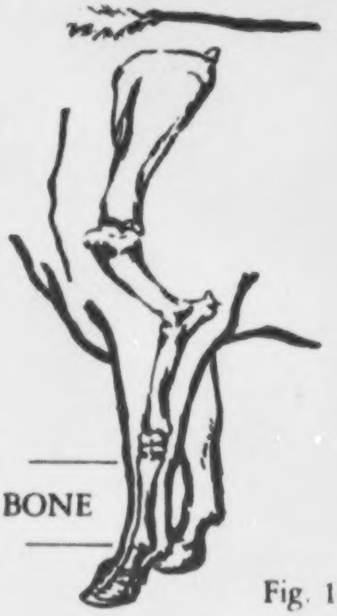
CANNON BONE

Fig. 1

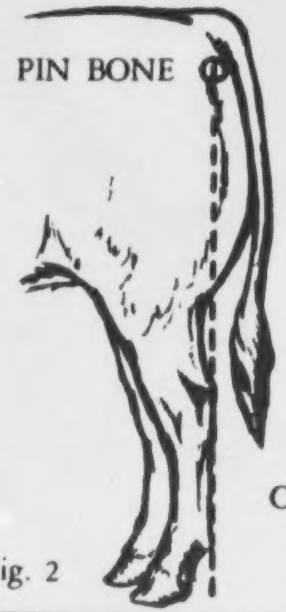
PIN BONE
CORRECT

Fig. 2

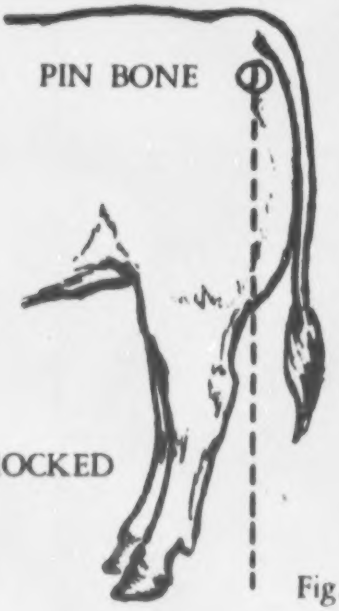
PIN BONE
SICKLE HOCKED

Fig. 3

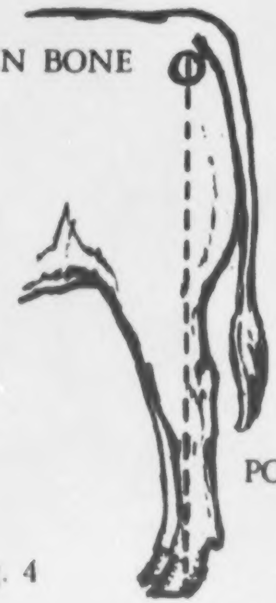
PIN BONE
POST LEGGED

Fig. 4

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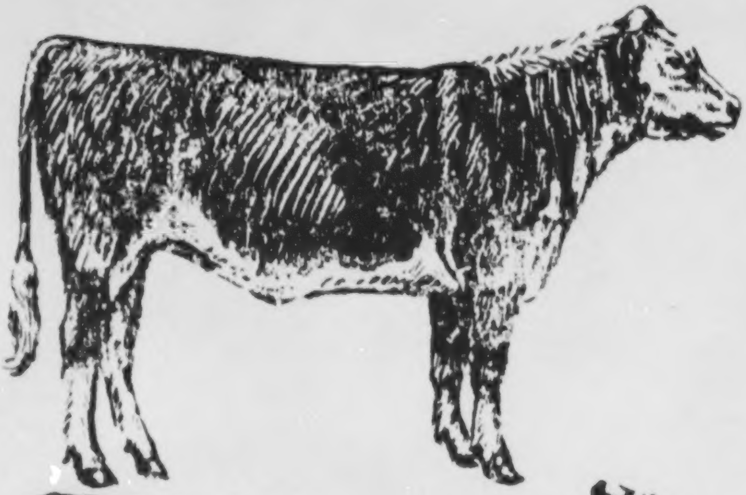
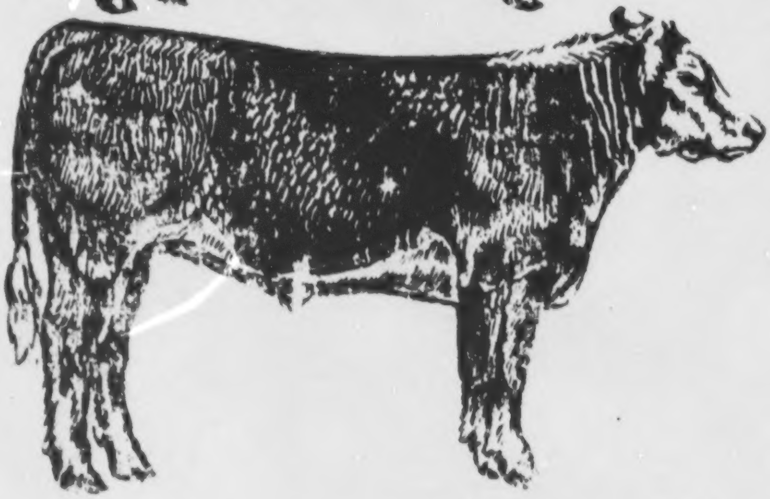
COMPARISON OF LIVE STEERS

VI-58 T

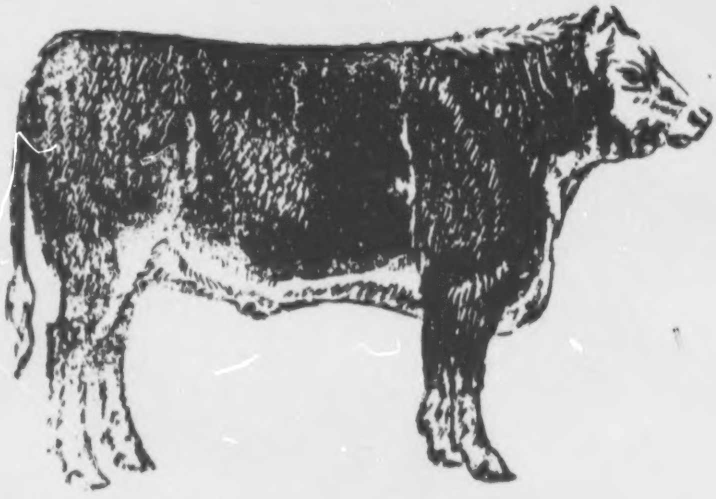
(SIDE VIEW)



STEER 1



STEER 2



STEER 3

Courtesy of Vocational Instructional Services
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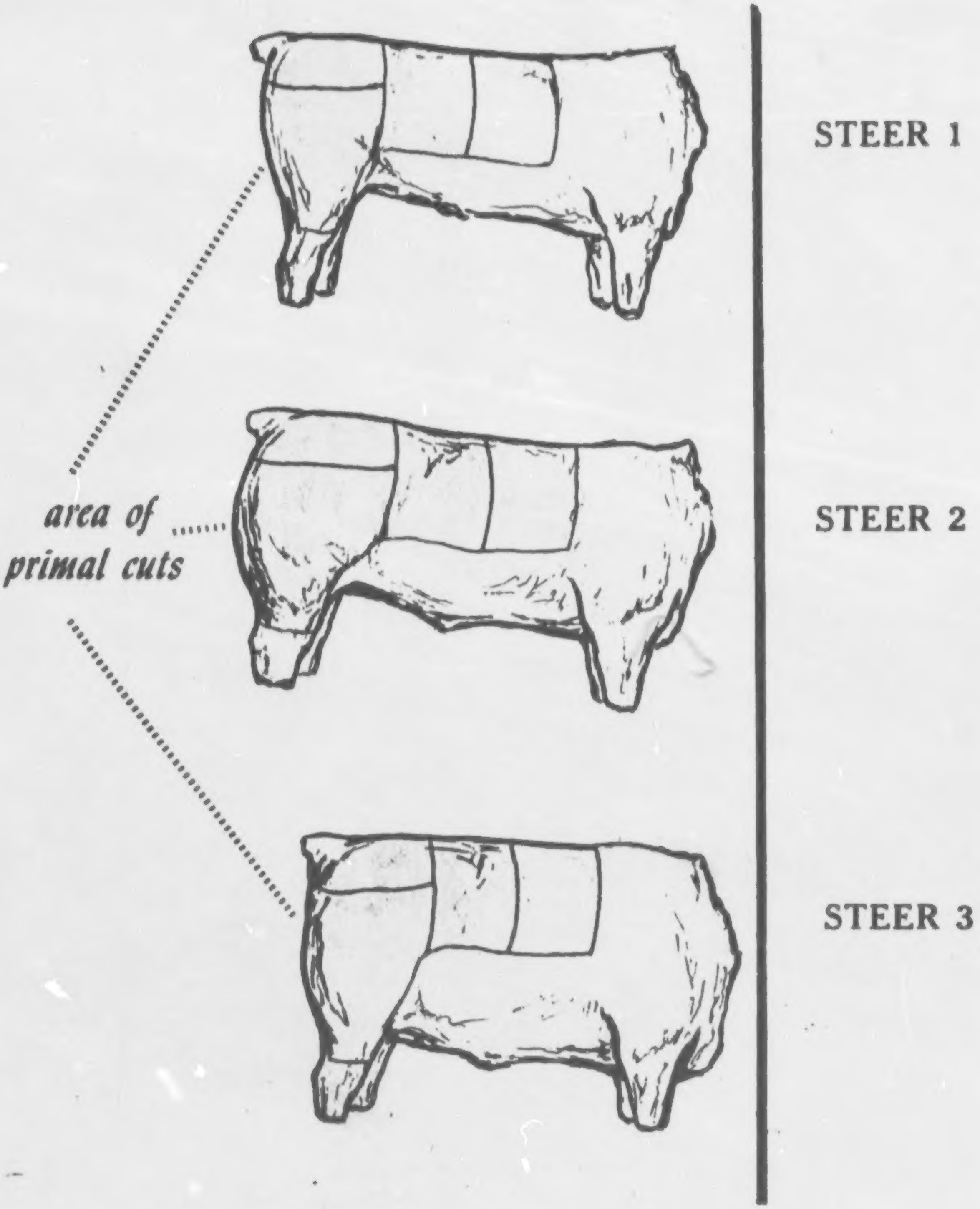
VI-59 T

COMPARISON OF STEER CARCASSES
(SIDE VIEW)


area of primal cuts
STEER 1
STEER 2
STEER 3

Courtesy of Vocational Instructional Services
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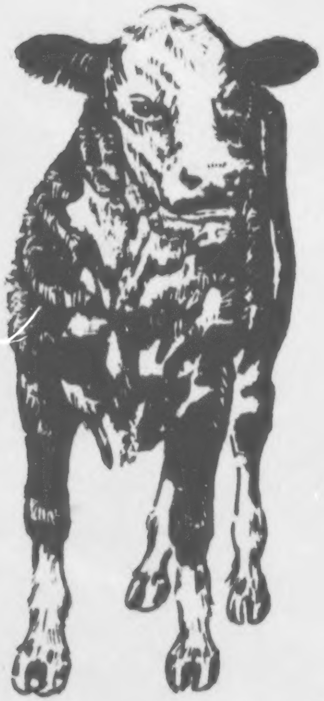
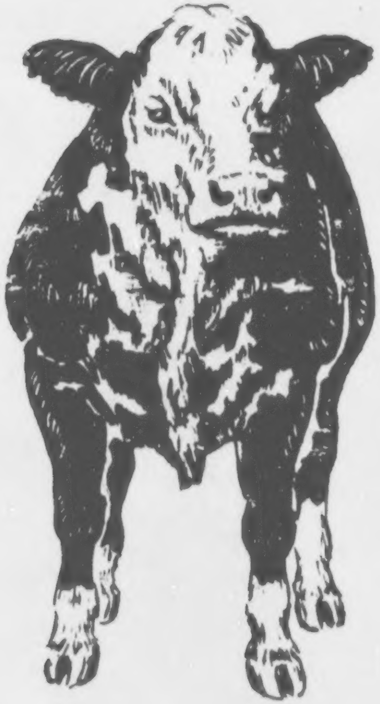
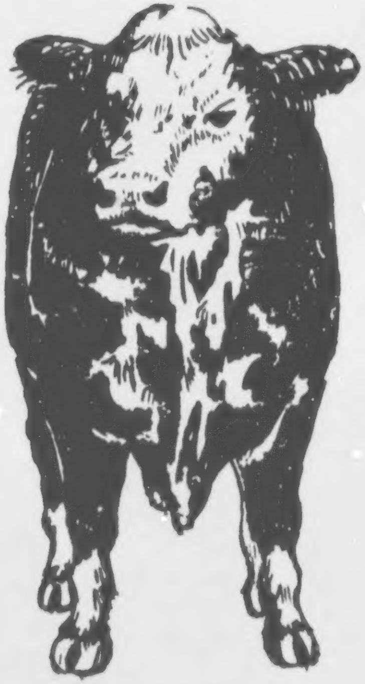
COMPARISON OF LIVE STEERS
(FRONT VIEW)



STEER 1



STEER 2



STEER 3

Courtesy of Vocational Instructional Services
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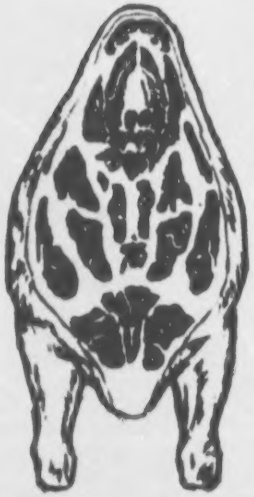
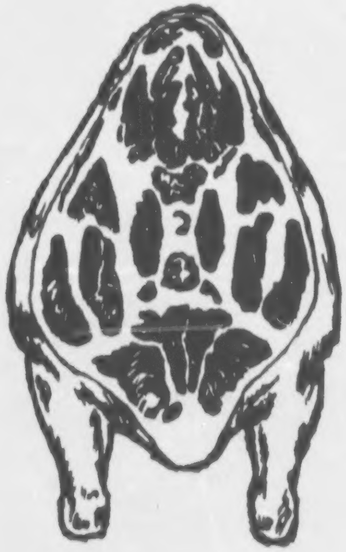
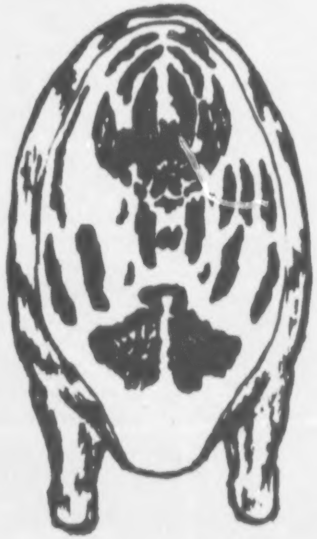
CROSS SECTION OF STEER CARCASSES
(FRONT VIEW)



STEER 1



STEER 2



STEER 3

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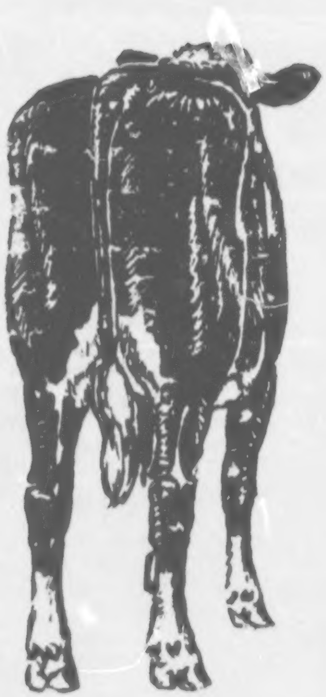
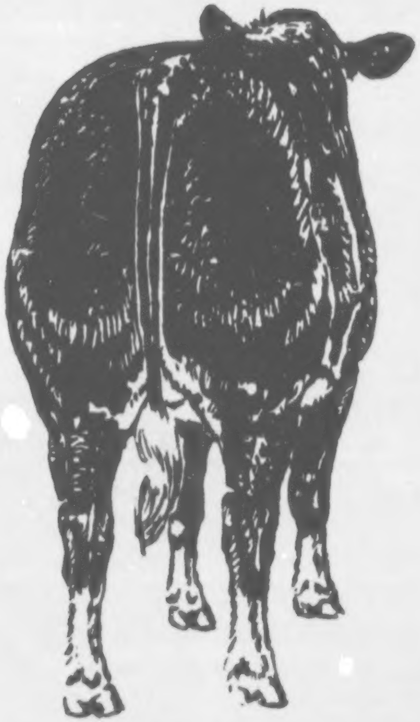
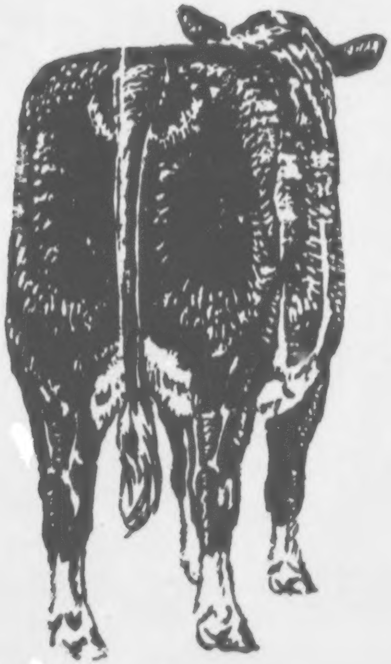
COMPARISON OF LIVE STEERS
(REAR VIEW)



STEER 1



STEER 2



STEER 3

VI-62 T

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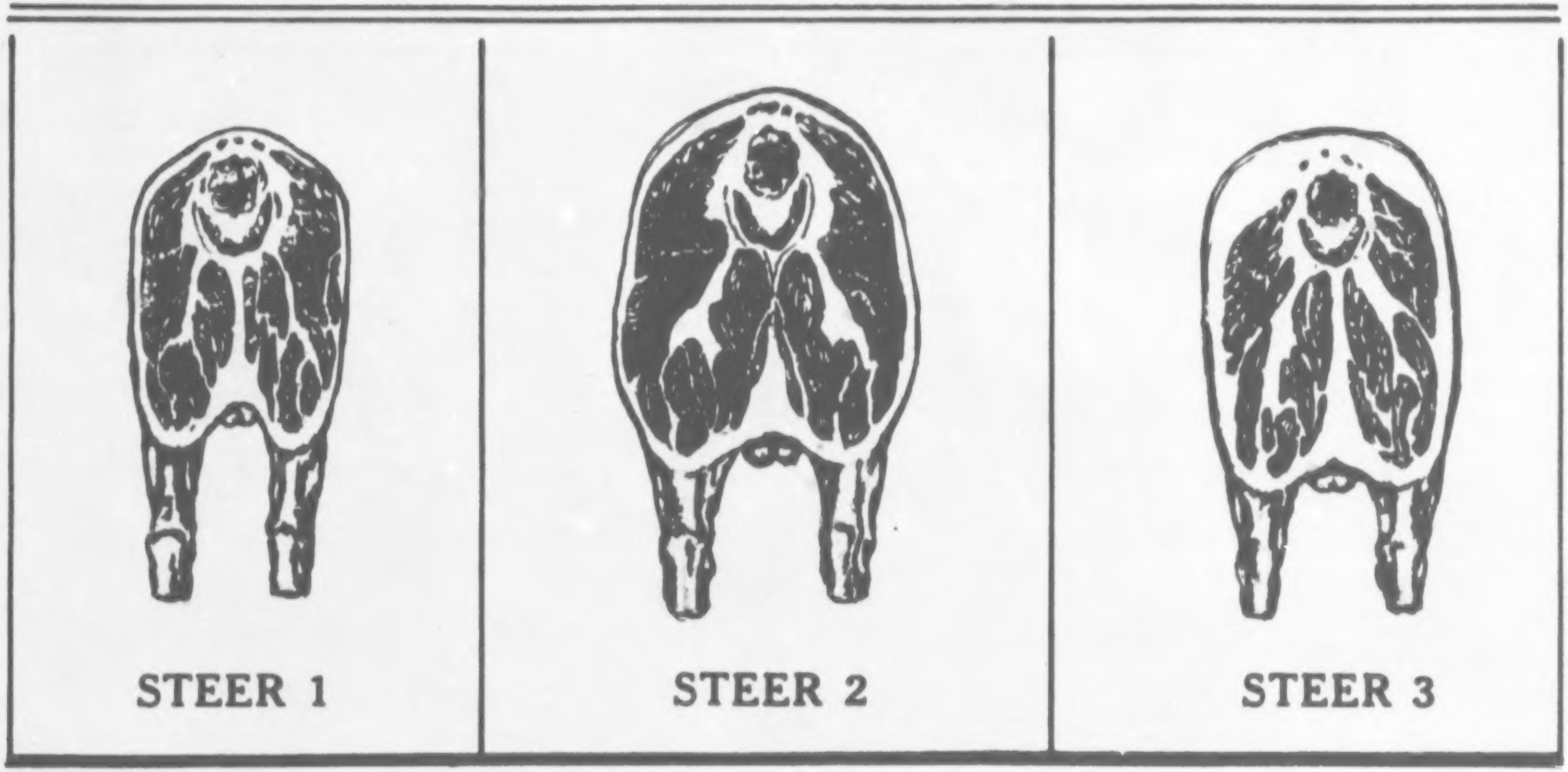
CROSS SECTION OF STEER CARCASSES
(REAR VIEW)



STEER 1

STEER 2

STEER 3

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LESSON 6: DAIRY CATTLE SELECTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List factors that influence selecting dairy cattle.
2. Select dairy animals based on body type.
3. Use production records to select dairy animals.
4. Judge and place dairy animal classes giving reasons for the placings.

MOTIVATION:

Ask students, "Why is it important to select a dairy cow from visual inspection when what we are after is milk production? What other methods do we use to select dairy cows?

REFERENCES:

Dairy Cattle Judging Techniques, Prentice Hall, Inc.

Principles of Dairy Science, Freeman Publishing Company

Hoard's Dairyman

Transparencies:
"Dairy Cow Unified Score Card"
"Dairy Character"
"Body Capacity"
"Mammary Development"
"Dairy Herd Improvement Records"
"Conversion Factors"
"Dairy Cattle Pedigree"

OUTLINE:

A. Factors Used in Dairy Breed Selection:

    1. Determine if the desired breeding stock is available.
    2. The types and amounts of forage crops and pasture available will determine the breed. Larger breeds require more roughages.
    3. The climate conditions since breeds have different abilities to withstand temperature extremes.

4. The age at which heifers reach maturity. Large breeds usually mature later than smaller breeds.

5. The availability of markets for milk and butterfat.

6. Select a breed common to the area in order to have a breeding stock supply.

7. Calf qualities in relation to size and vigor and ease of calving for cows is a consideration.

B. Body Type:

1. Parts of Dairy Cow (see transparency)

2. Value given to specific areas:

   a. Five major dairy breeds cooperated through Purebred Dairy Cattle Association in development of unified score card
   b. Areas to observe are general appearance, dairy character, body capacity, and mammary system.

3. Characteristics to view in each area that represents dairy type:

   a. Dairy character involves consideration of:

      1) Angularity
      2) Freedom of coarseness
      3) Neck
      4) Withers
      5) Ribs
      6) Thighs
      7) Flanks
      8) Skin
      9) Milking ability

   b. General appearance involves consideration of:

      1) Size
      2) Legs and feet
      3) Rump
      4) Hook bones (hips)
      5) Back
      6) Shoulders
      7) Head

   c. Body capacity involves consideration of:

      1) A long, deep barrel increasing in depth towards the rear
      2) Wide sprung ribs
      3) Large, deep heart girth blending into shoulders
      4) Wide chest floor
      5) Full crops

   d. Mammary system involves consideration of:

      1) Udder - strong attachments, balanced, deep and wide, and soft and pliable
      2) Rear udder - wide, strongly attached, uniform and high

3) Fore udder - moderate in length and uniform width from front to rear
4) Mammary veins - long, large
5) Teats - squarely placed, plumb and medium in length

C. Production Records: (see transparency)

D. Conversion tables to standardize records (see transparency) example on use courtesy of Vocational Instructional Services, Texas A & M University.

Suppose you have a Holstein cow that has just completed a 315-day lactation record which she began as a 4-year old. She was milked three times daily and produced 500 pounds of butterfat. First, look at the "age" section. The production of a 4-year old Holstein should be multiplied by 1.08, so multiply 500 x 1.08 which equals 540 pounds of butterfat. Next, look at the "3 x milking records" section. A 315-day lactation record should be multiplied by .98. By multiplying 469 x .98 the final answer is 460 pounds of butterfat. This figure is now standardized and can be plotted on a chart.

E. Selection of heifers based on mammary development. Choose for one with larger gland at a given age will tend to be the best milker.

F. Pedigree Selection: (see transparency)

1. Includes list of ancestors and some contain production records and type classification.

2. Most show three generations.

3. Should mainly consider the sire and dam because they contribute 50% to the animal's make-up.

TEACHING LEARNING ACTIVITIES:

1. Hand out diagrams and review the parts of the dairy cow.

2. Lead the class in discussion on what characteristics should be considered in dairy cow selection. Refer to the four areas and characteristics in the outline.

3. To aid in discussion of body types, show the three transparencies related to the discussion.

4. Ask the students for other suggestions of how to select dairy stock.

5. Show, "Dairy Herd Improvement Records," and discuss the importance of using them for selection.

6. Show how conversion tables can be used to standardize production records for selection. (See outline and transparency)

7. Lead discussion on why pedigrees should be used in dairy stock selection. Show the pedigree transparency. Make a ditto of modern pedigree. Compare that pedigree with the transparency.

8. Review dairy selection for body type and take a field trip to judge classes of dairy stock.

SUGGESTED EVALUATION:

1. Quiz students over class discussions.

2. Assign grades to judging, conversion table assignment.

DAIRY COW UNIFIED SCORE CARD

VI-68 T

BREED CHARACTERISTICS SHOULD BE CONSIDERED IN THE APPLICATION OF THIS SCORE CARD		Perfect Score
Order of Observation		
1. GENERAL APPEARANCE		**30**
(ATTRACTIVE INDIVIDUALITY WITH FEMININITY, VIGOR, STRETCH, SCALE, HARMONIOUS BLENDING OF ALL PARTS AND IMPRESSIVE STYLE AND CARRIAGE. ALL PARTS OF A COW SHOULD BE CONSIDERED IN EVALUATING A COW'S GENERAL APPEARANCE)		
BREED CHARACTERISTICS	10	
COLOR		
SIZE		
HEAD		
SHOULDER BLADES	10	
BACK		
RUMP		
LEGS AND FEET	10	
2. DAIRY CHARACTER		**20**
(EVIDENCE OF MILKING ABILITY, ANGULARITY, AND GENERAL OPENNESS, WITHOUT WEAKNESS, FREEDOM FROM COARSENESS, GIVING DUE REGARD TO PERIOD OF LACTATION)		
NECK	20	
3. BODY CAPACITY		**20**
(RELATIVELY LARGE IN PROPORTION TO SIZE OF ANIMAL, PROVIDING AMPLE CAPACITY, STRENGTH, AND VIGOR)		
BARREL	10	
HEART GIRTH	10	
4. MAMMARY SYSTEM		**30**
(A STRONGLY ATTACHED, WELL BALANCED, CAPACIOUS UDDER OF FINE TEXTURE INDICATING HEAVY PRODUCTION AND A LONG PERIOD OF USEFULNESS)		
UDDER	10	
FORE UDDER	6	
REAR UDDER	7	
TEATS	5	
MAMMARY VEINS	2	
TOTAL		**100**

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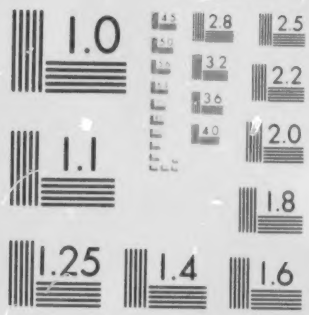
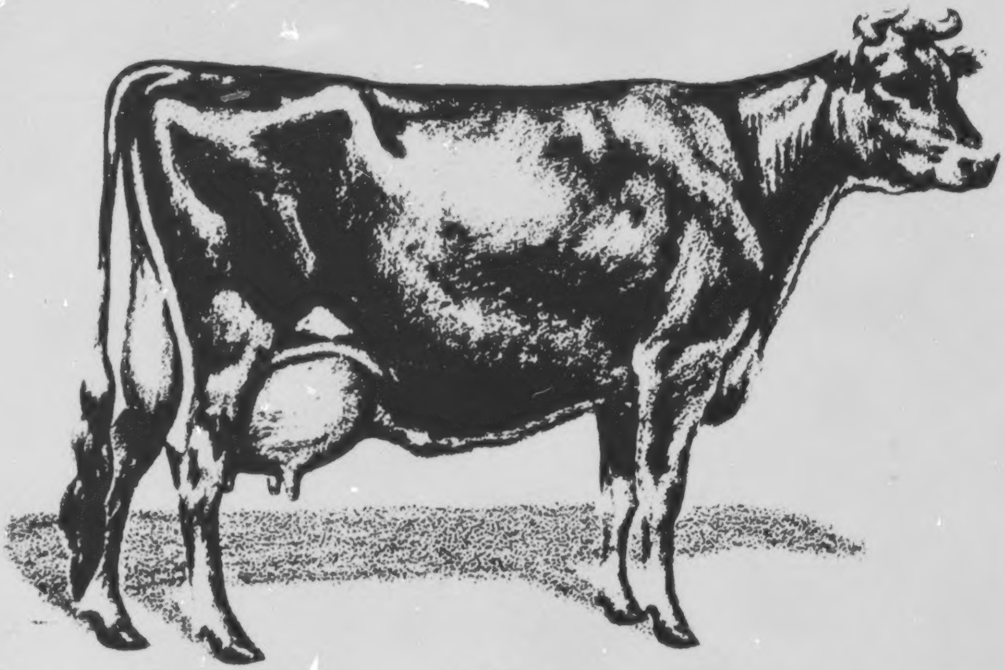
B.m

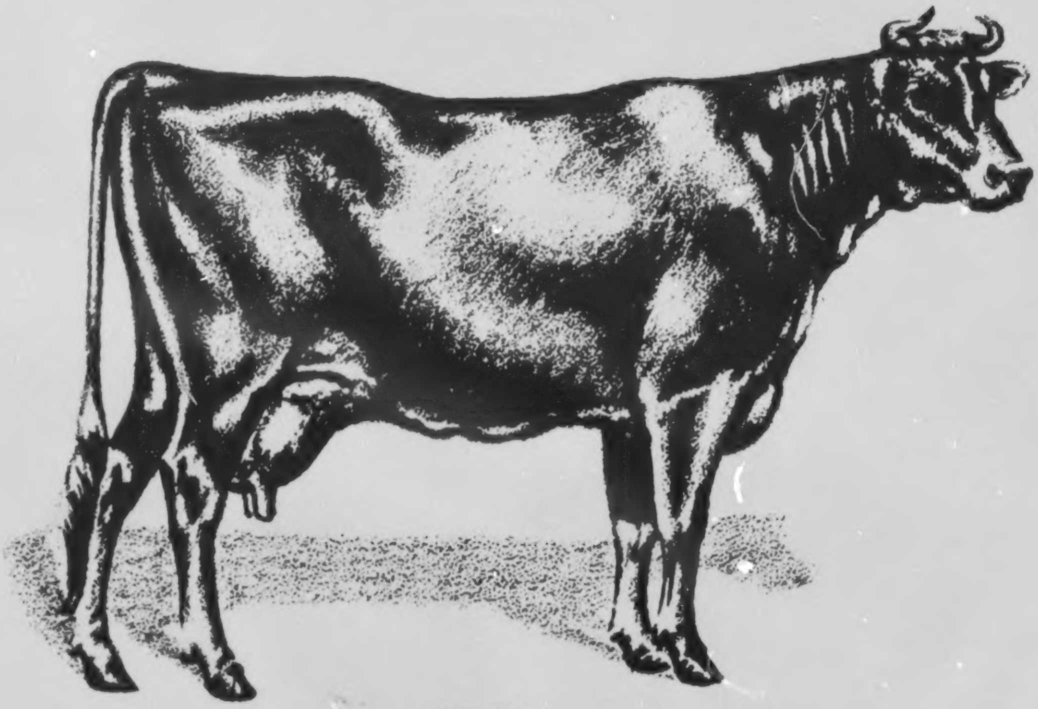

1.0
4.5
5.0
5.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DAIRY CHARACTER



GOOD



POOR

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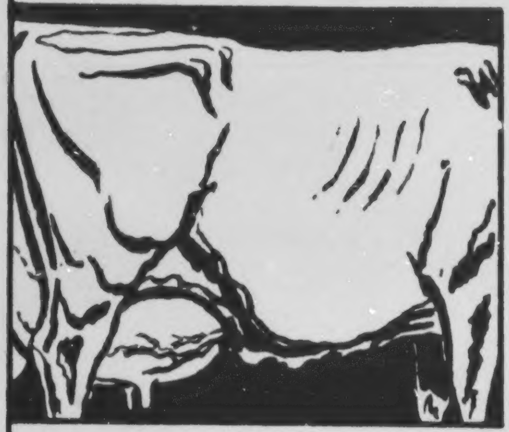
VI-70 T

BODY CAPACITY



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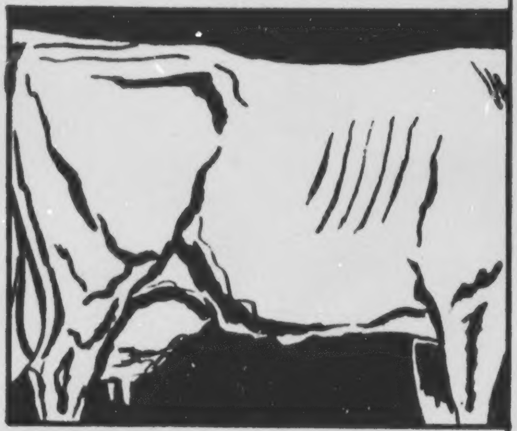

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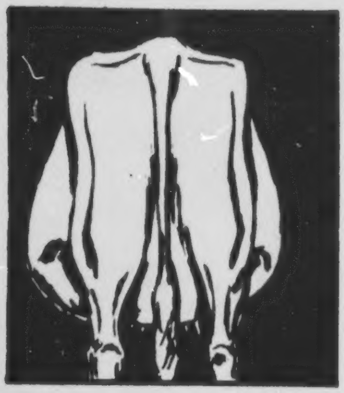

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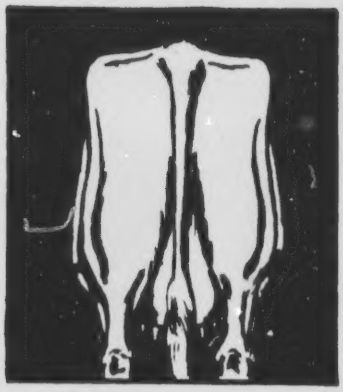

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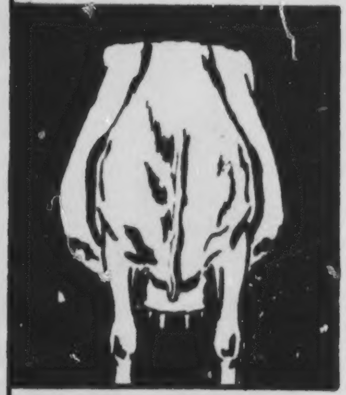
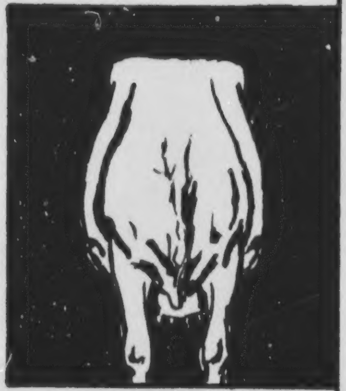


GOOD



POOR

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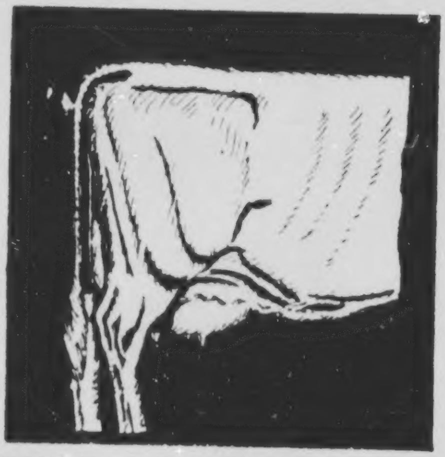
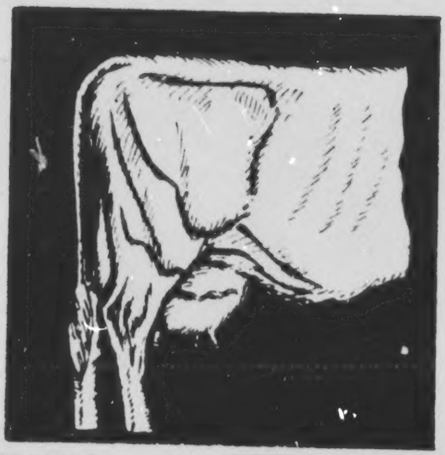
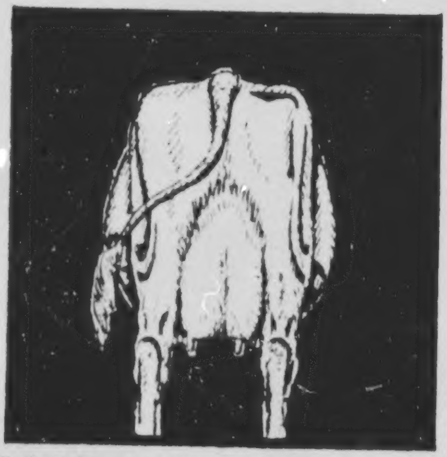
MAMMARY DEVELOPMENT



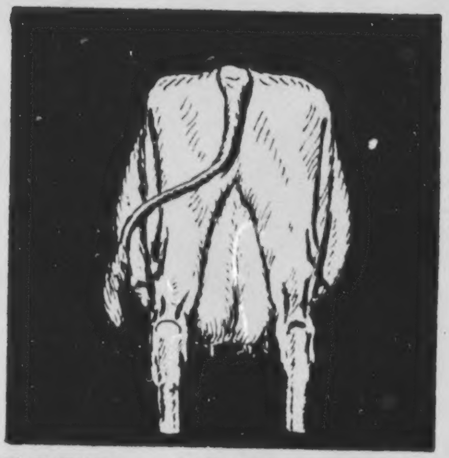
GOOD UDDER AND FORE UDDER ATTACHMENT



POOR UDDER AND FORE UDDER ATTACHMENT



GOOD UDDER AND REAR UDDER ATTACHMENT



POOR UDDER AND REAR UDDER ATTACHMENT

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

DAIRY HERD IMPROVEMENT RECORDS

BARN SHEET--DHI-201

BREED	REGISTRATION OR EAR-TAG NO.	COW INDEX NO.	LAST TEST DAY DATA				CURRENT TEST DAY DATA							REPRODUCTIVE STATUS		SIRE OR CALF ID
			DAILY MILK WEIGHTS LBS.	%B-FAT	DATE		MILKING WTS		%B-FAT	SAMPLE NO.	DATE		CONC. FED LBS.	LAST DATE BRED	DATE DUE	
					MO.	DAY	1ST	2ND			MO.	DAY				
3	64WAF4203	0002	33.0	3.3	9	25	17.5	18.0	3.5	6	10	25	16	8-18-73	5-28-74	H78

LACTATION RECORDS TO DATE ENTERED HERD

INDEX NUMBER	LAST MONTH		DATE OF FRESHENING			NUMBER DAYS		MILK POUNDS	FAT POUNDS	VALUE PRODUCT	INCOME OVER FEED COST
	DAILY MILK WEIGHTS	%B-FAT	MO.	DAY	YEAR	DRY	IN MILK				
0061	44.3	4.0	12	15	72		215	9,521	503	495.00	250.00

MONTHLY HERD DATA

GROUP	SILAGE		DRY FORAGE		GROUP FED CONC.		PASTURE		CONCENTRATES	
DRY	LBS. CONS. ENE	COST TON	LBS. CONS. ENE	COST TON	LBS. CONS. ENE	COST TON	QUALITY	COST/M	ENE	COST TON
3										
MILK										
2										
MILK			8.0	$36.00						$123.00

DATE OF TEST			BULK TANK WEIGHTS(LBS.)		MILK PRICING INFORMATION					BEGINNING TIME OF MILKING				REPORT FOR MONTH OF
MO.	DAY	YEAR	NO. MILKINGS	TOTAL LBS. OF MILK	NET/CWT.		%B-FAT	B-FAT DIFF.		A. M.		P. M.		
					$	CENTS		CENTS	10TH	HOUR	MIN.	HOUR	MIN.	
9	25	73			9	82	3.8	0	09	6	15	5	15	SEPT.

SUPERVISOR NAME

WALKER

VI-72 T

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VI-73 T

CONVERSION FACTORS

(USED TO STANDARDIZE RECORDS)

AGE

(BASED ON AGE WHEN PRODUCTION RECORD WAS BEGUN)

AGE YR., MO.	AYRSHIRE	BROWN SWISS	GUERNSEY	HOLSTEIN	JERSEY	MILKING SHORTHORN
2—0	1.30	1.45	1.24	1.31	1.27	1.42
3—0	1.18	1.23	1.12	1.18	1.15	1.24
4—0	1.10	1.10	1.06	1.08	1.06	1.13
5—0	1.03	1.04	1.02	1.02	1.02	1.07
6—0	1.00	1.00	1.00	1.00	1.00	1.01
7—0	1.00	1.00	1.00	1.00	1.00	1.00

3X MILKING RECORDS

AGE AT CALVING	FACTORS FOR 3X RECORDS
2 TO 3 YEARS	.83
3 TO 4 YEARS	.85
4 YEARS AND OVER	.87

LENGTH OF LACTATION

240 DAYS OR LESS	1.15	335 DAYS	.93
315 DAYS	.98	355 DAYS	.89

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College Station, Texas 77843

DAIRY CATTLE PEDIGREE

(NAME & REGISTRATION NO.)
CLASSIFIED VG

	#M	%	#F
2 REC. AV.	9775	5.2	508

SIRE
(NAME & REGISTRATION NO.)
CLASSIFIED EX

	#M	%	#F
12 DAUS. AV.	9150	5.2	476
12 DAMS AV.	8800	5.0	440
	+350	+0.2	+36

10 DAUS. CLASSIFIED AV. 84.1

GRAND SIRE
(NAME & REGISTRATION NO.)
CLASSIFIED VG

	#M	%	#F
10 DAUS. AV.	8500	4.9	417

10 DAUS. CLASSIFIED AV. 84.0

GRAND DAM
(NAME & REGISTRATION NO.)
CLASSIFIED VG

	#M	%	#F
4 REC. AV.	8900	5.5	489

DAM
(NAME & REGISTRATION NO.)
CLASSIFIED GP

	#M	%	#F
3 REC. AV.	9200	5.0	460
2 DAUS. AV.	9100	5.3	482

GRAND SIRE
(NAME & REGISTRATION NO.)
CLASSIFIED GP

	#M	%	#F
15 DAUS. AV.	8750	5.2	446
15 DAMS AV.	8600	4.9	421
	+150	+0.2	+25

GRAND DAM
(NAME & REGISTRATION NO.)
CLASSIFIED VG

	#M	%	#F
3 REC. AV.	9700	5.0	485

NOTE: ALL RECORDS ADJUSTED TO 2X-305 DAYS MATURE EQUIVALENT BASIS.

DAIRY CATTLE PEDIGREE TERMS AND ABBREVIATIONS

1. 2X-305 Days - Milked twice a day for 305 days; the records on most pedigrees are adjusted to 2X-305 days mature equivalent basis.
2. #M - Pounds of milk
3. % - Percent of butterfat
4. REC. - Record(s)
5. #F - Pounds of butterfat
6. AV. - Average
7. DAUS. - Daughters

VI-74 T

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LESSON 7: HORSE SELECTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Locate and write in the parts on a diagram of a horse.
2. List areas to measure to determine balance in conformation.
3. Describe, in writing, the defects that should be noted when selecting horses.
4. Judge and place a class of stock horses.

MOTIVATION:

Ask students if all horse trainers and breeders select horses using the same specifications. If not, why? Get students involved in discussing how the breeds differ in conformation, gaits, and general uses.

REFERENCES:

The Horse, W. H. Freeman and Co.

4-H Horse Judging Manual, Purdue University

Transparency Masters: "Parts of the Horse"
"Correct Balance in Conformation"
"Ideal Stock Horse Conformation"
"Common Conformation Defects" (3 pages)

OUTLINE:

A. Parts of a Horse (see transparency master)

B. Correct Conformation - Rules of Thumb (see transparency on correct balance)

  1. Length from point of shoulder to top of front of withers:

    a. length of back and loin (B)
    b. length from point of hip to buttock (C)
    c. length from center of neck at attachment to shoulder to center (D) of neck at attachment to head should all be equal (i.e. ,B=C=D)

2. Length of foreleg from body to center of joint of the cannon and pastern bones (E) equal to length top of withers to floor of chest (heart girth) (F) (for mature horse only)

3. Height at top of withers equal height at top of hip.

C. Conformation Defects (see transparency masters on conformation defects)

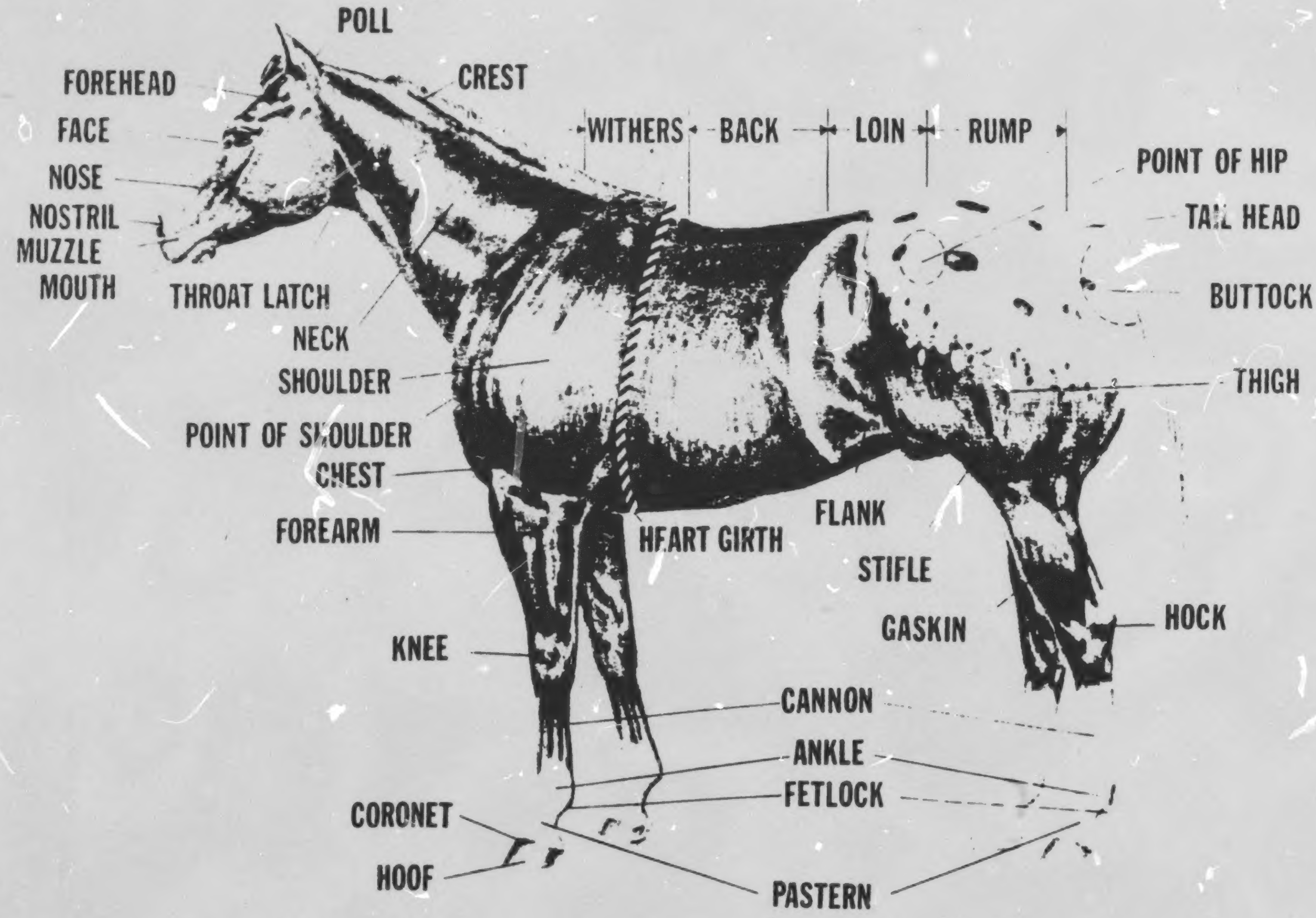
TEACHING LEARNING ACTIVITIES

1. Show the transparency and review the parts of a horse.
2. Discuss what is meant by balance. Show the transparency on balance in conformation to determine what areas to look for.
3. Discuss what to look for in the ideal horse. Ask if there are any differences of conformation in breeds. Have students select a breed and determine conformation characteristics and report to class.
4. Invite owners and/or trainers of specific breeds to speak in class on conformation and other characteristics of specific breeds and possibly bring in a horse to use as an example.
5. Take a field trip to view horse training and exhibition of breeds.
6. Review conformation defects from the transparencies.
7. Take class on a field trip to judge classes of horses.

SUGGESTED EVALUATION:

1. A written quiz on conformation and other material discussed during the lesson.
2. Assign grades to placings and written reasons from judging classes.

PARTS OF THE HORSE


POLL
FOREHEAD
CREST
FACE
WITHERS
BACK
LOIN
RUMP
NOSE
POINT OF HIP
NOSTRIL
TAIL HEAD
MUZZLE
MOUTH
THROAT LATCH
BUTTOCK
NECK
SHOULDER
THIGH
POINT OF SHOULDER
CHEST
FLANK
FOREARM
HEART GIRTH
STIFLE
GASKIN
HOCK
KNEE
CANNON
ANKLE
FETLOCK
CORONET
HOOF
PASTERN

VI-77 T

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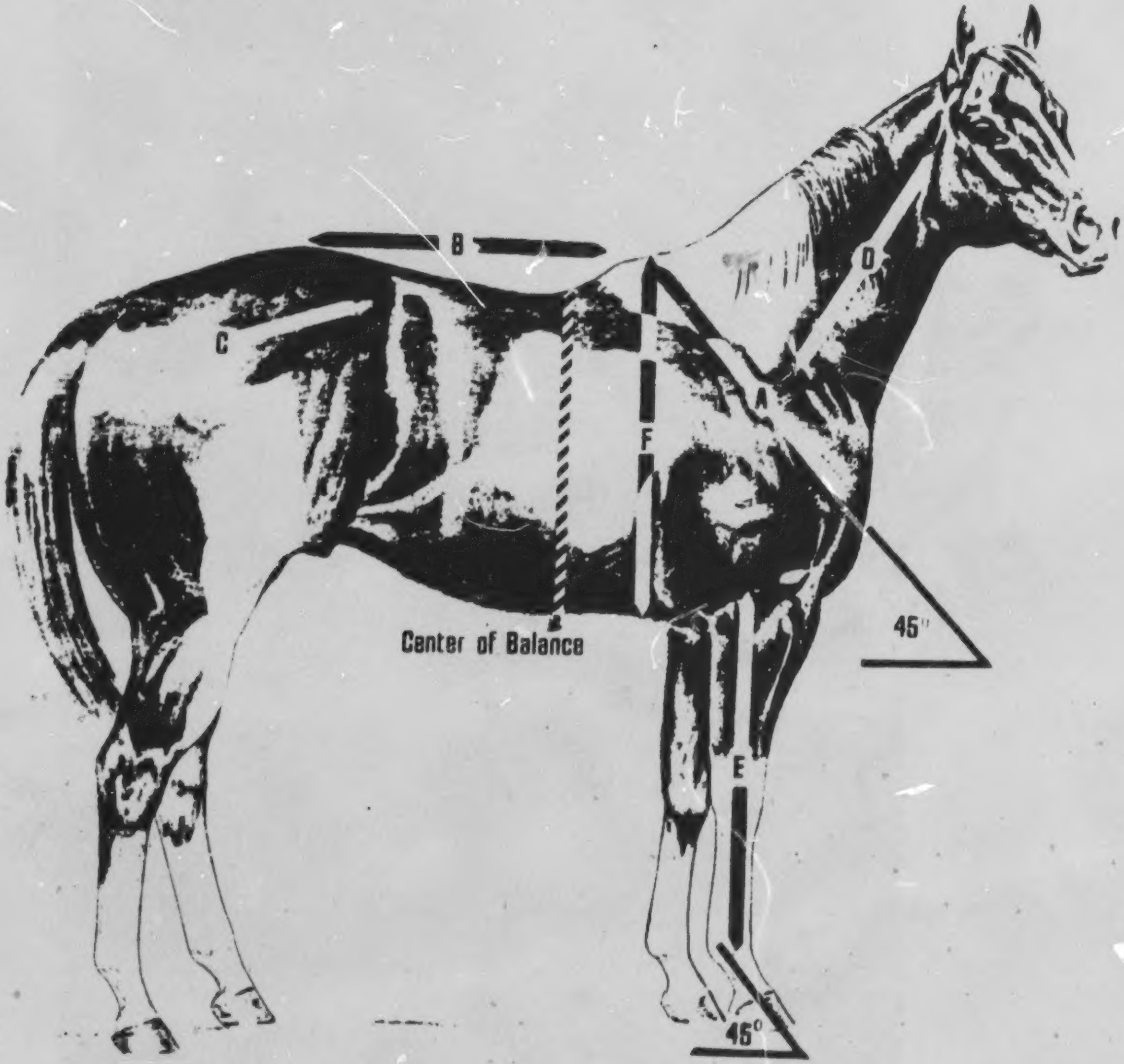
Correct Balance In Conformation


B
C
D
A
F
Center of Balance
45°
E
45°

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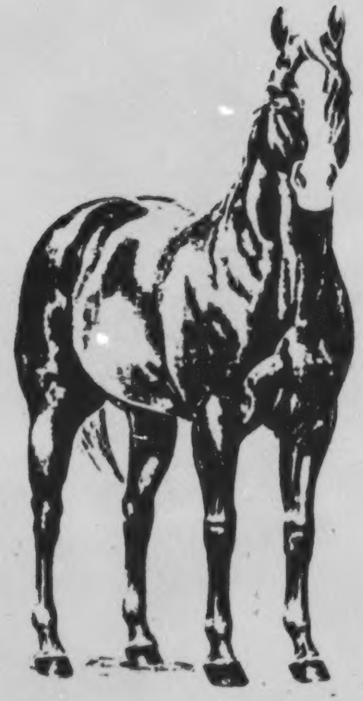
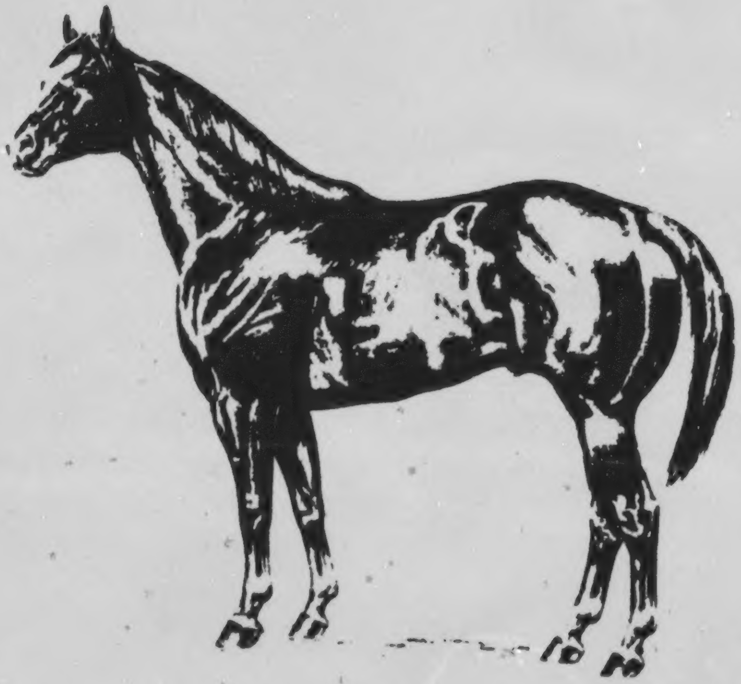
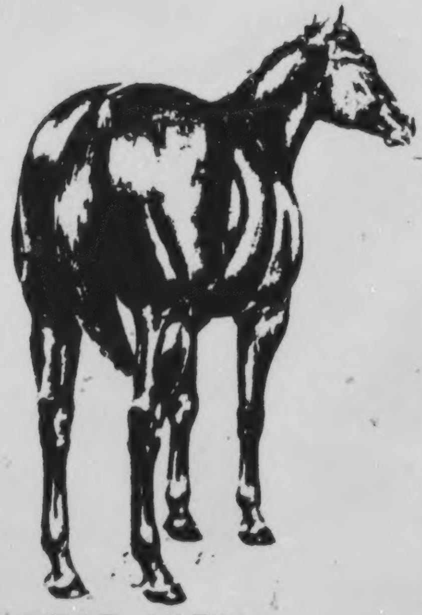
IDEAL STOCK HORSE CONFORMATION



FRONT VIEW



SIDE VIEW



REAR VIEW

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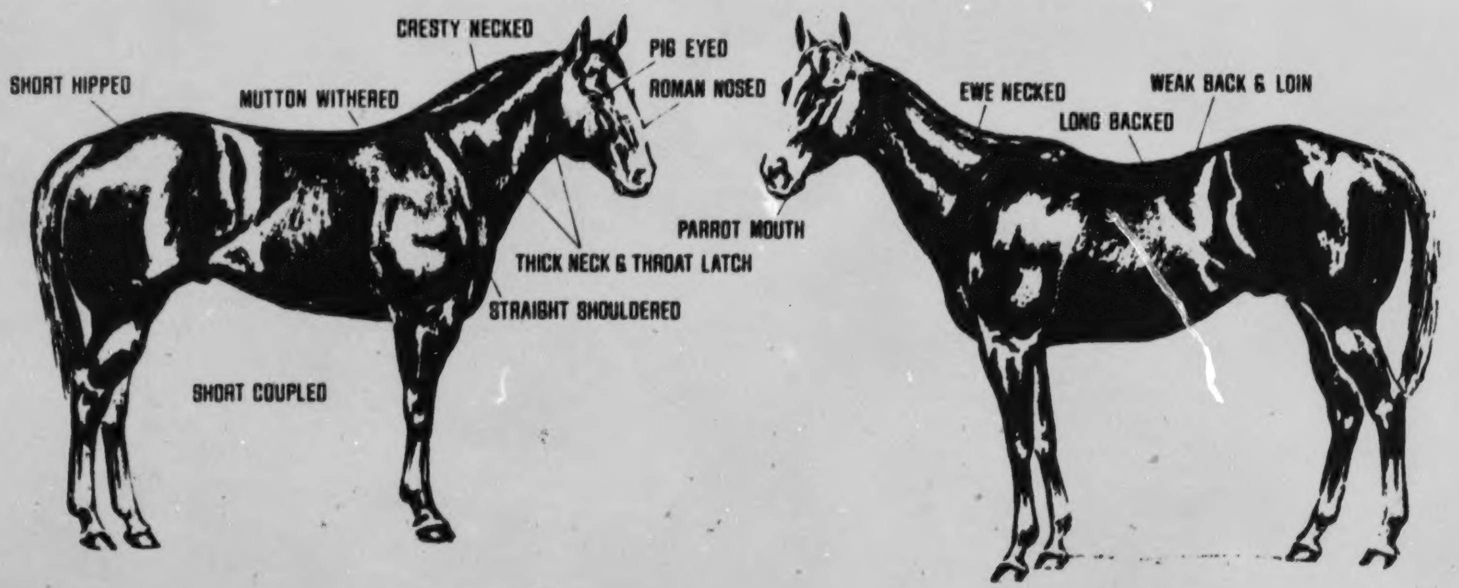
COMMON CONFORMATION DEFECTS

(head, neck and body)


CRESTY NECKED
PIG EYED
SHORT HIPPED
MUTTON WITHERED
ROMAN NOSED
EWE NECKED
WEAK BACK & LOIN
LONG BACKED
PARROT MOUTH
THICK NECK & THROAT LATCH
STRAIGHT SHOULDERED
SHORT COUPLED

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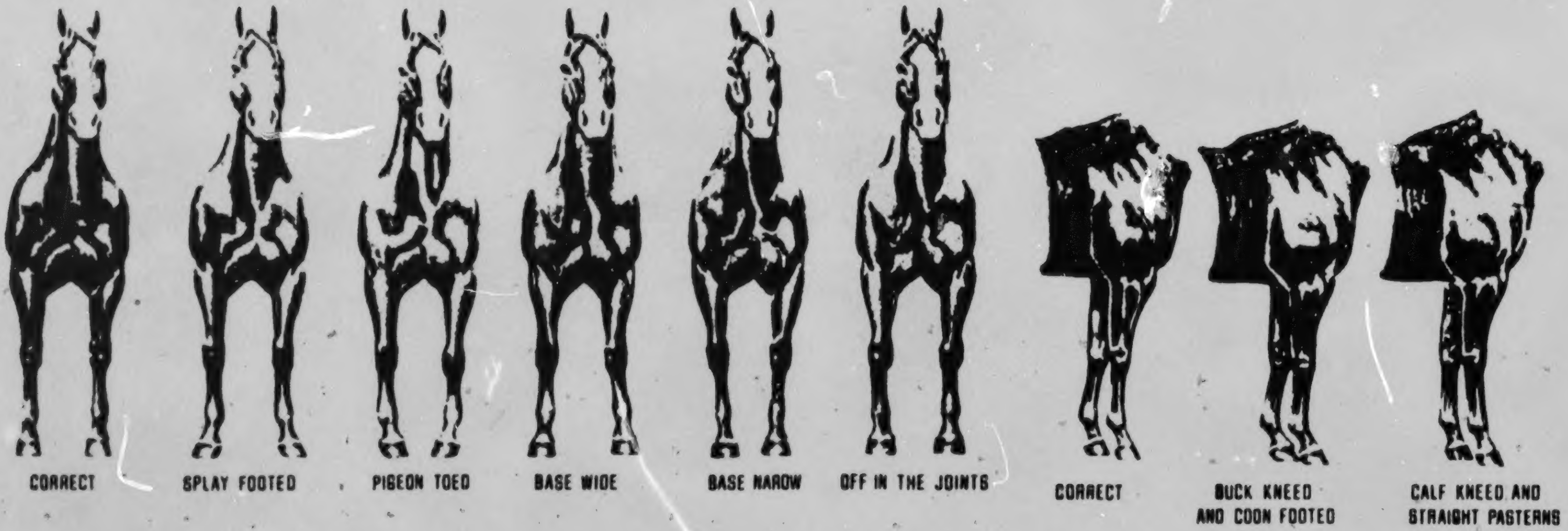
400

VI-80 T

COMMON CONFORMATION DEFECTS (front legs)


CORRECT
SPLAY FOOTED
PIGEON TOED
BASE WIDE
BASE NAROW
OFF IN THE JOINTS
CORRECT
BUCK KNEED AND COON FOOTED
CALF KNEED AND STRAIGHT PASTERNS

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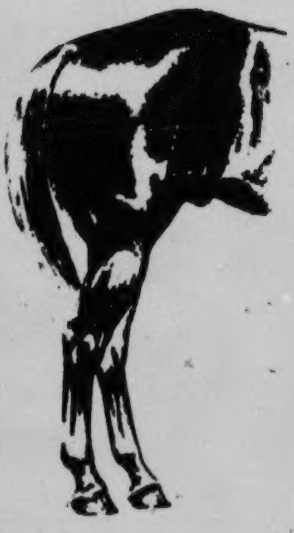
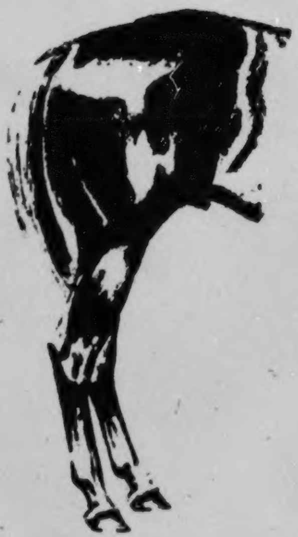
VI-81 T

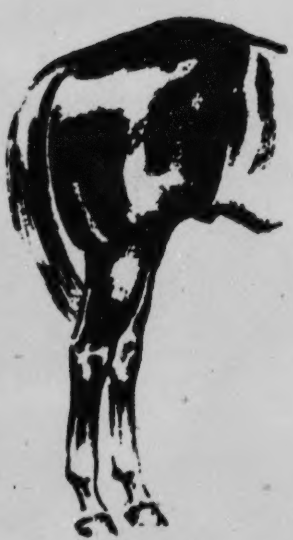
COMMON CONFORMATION DEFECTS (hind legs)



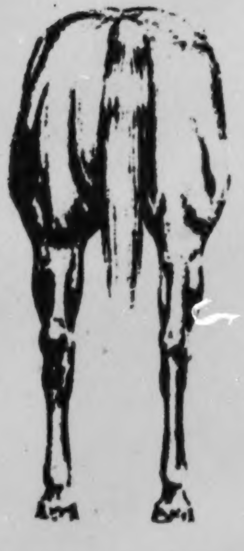
CORRECT



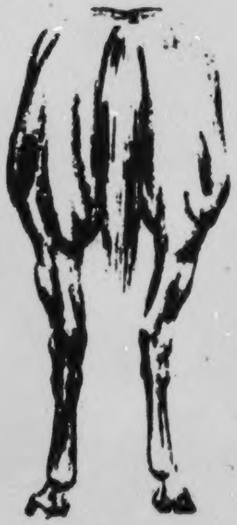
SICKLE HOCKED



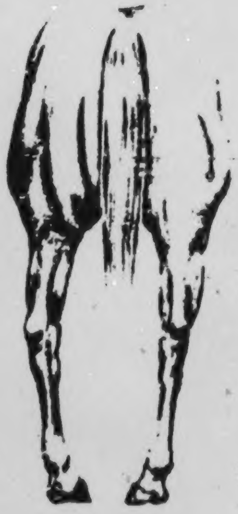
POST LEGGED



CORRECT



COW HOCKED



BANDY LEGGED

403

404

VI-82 T

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LESSON 8: POULTRY SELECTION AND EGG GRADING

OBJECTIVES

At the completion of the lesson the student will be able to:

1. Demonstrate the proper procedure for handling a chicken.
2. Locate and write in the parts of a chicken on a diagram.
3. Give a written explanation of how to compare a hen that is laying with one that is not.
4. State the length of time that a hen has been laying from the bleaching of yellow pigments at points on the body.
5. Demonstrate how to determine length of time since a hen has stopped laying by the molting stage.
6. Select hens that are laying from a group of chickens.
7. Place a class of hens in order according to laying ability as noted in bleaching of pigmentation and conformation.
8. Cull out birds that exhibit undesirable characteristics.
9. Judge and place a poultry class for meat qualities.
10. Judge and grade dressed ready-to-cook poultry.
11. Candle and grade eggs.

MOTIVATION:

Bring in some chickens to class. Demonstrate to the students how to handle a chicken. Ask the students to tell you if the chickens have recently laid an egg. Tell the students which hens are laying and which aren't.

REFERENCES:

How to Judge Poultry and Eggs, Purdue University P-95

Sample Questions for 4-H and FFA Poultry and Egg Judging Contests, Purdue University P-62

Livestock and Poultry Production, Chapter 36, Prentice Hall, Inc.

Transparencies: "Parts of a Chicken"
"Factors to Consider in Selecting Pullets"
"Pullet Conformation"
"Factors to Consider in Selecting Flock Replacements"
"Layer Conformation"
"Evaluating Hens for Rate of Egg Production Past & Present"
"Broiler Conformation"

OUTLINE:

A. Handling Chickens:

1. Maneuver the chickens in coop until its head is facing your right.

2. Right hand placed over chickens back and grasp opposite wing firmly keeping the wing folded.

3. Bring the chicken toward you with its head pointed toward the coop door.

4. Place left hand with palm upward against the bird's breast using your thumb to hold the wing.

5. Lift chicken from coop sliding left hand back to grasp the legs.

B. Parts of a Chicken (see transparency)

C. Determining When Hen is Laying From Observations:

Body Part	Laying	Not Laying
Comb	Red, waxy, full	Dull, scaly, shrunken
Vent	Large, moist, faded	Small, dry, yellow
Abdomen	Soft, pliable	Hard, firm
Pelvic bones	Thin, pliable	Thick, rigid
Spread between Pelvic bones	More than two fingers	Two fingers or less
Spread from keel to pelvic bones	More than three fingers	Three fingers or less
Beak	Faded or starting to fade at corners of mouth	Yellow or turning yellow at corners of mouth

D. Laying Time Determination From Pigments:

1. All pigment from feed is used in the egg yolk. Pigment in body parts fades and is not replaced as long as hen is laying eggs.

2. Length into the laying period can be determined by examining the pigment fading in the:

a.	Vent	5-7 days
b.	Eye ring	10-14 days
c.	Ear lobes	10-14 days
d.	Beak	4-6 weeks
e.	Shanks	4-6 months

E. Molting Related to Laying:

1. Usually when molting occurs, the hen stops laying.

2. Partial molts of body or wing feathers can occur at any time and means the hen has taken a short break from laying.

3. Early molters are usually poor layers.

4. Order of molt:

    a. Starts at head, neck and body
    b. Wing feathers consist of primaries and secondaries
    c. Primary wing feathers molt beginning next to the axial feather (the feather that separates the primaries from secondaries)

5. Fast molters may drop more than one feather at a time and are intense layers or have a high number of eggs laid in a month.

F. Physical Characteristics of High Rate Layers:

1. Well-balanced refined head, moderately wide and deep.

2. Prominent, alert eyes and lean, clean cut face.

3. Deep body with a broad back.

4. Skin is soft, thin, and pliable.

G. Culling Qualities:

1. Thin or underweight.

2. Poor body development.

3. Diseases:

   a. Leukosis eye
   b. Marble bone shanks
   c. Tumors or sores on skin
   d. Water tumor (abdomen)
   e. Lack of vitality.

4. Deformities:

   a. Badly crossed beak
   b. Severely crooked keel or back
   c. Crooked toes or legs interfere with walk

5. Not true to breed.

6. Showing signs of poor past production and presently out of production.

7. Pullets small and immature for age, abnormal paleness of shanks and beaks.

H. Characteristics for Meat Quality:

1. Fleshing - well covered with flesh especially over breast, thighs, and legs. Breast give a well-rounded appearance.

2. Feathering - fully developed feathers over body, very small amount of pinfeathers.

3. Body shape - compact, broad breast, long straight keel bone, short legs.

4. Finish - even fat covering (well-distributed).

5. Freedom from defects.

I. Dressed Poultry Characteristics (see handout)

J. Egg Parts:

1. Bloom or cuticle - protective shell covering and when rubbed off by washing opens up to bacteria or mold growth.

2. Shell - Is porous and is mostly lime.

3. Membranes - two membranes line the inside of the shell. When egg is first laid the egg fills the shell and as cooled air is drawn in separating the two membranes to make an air cell in the large end.

4. Albumen (egg white) - consists of the thin white on outside, thick white - holds an egg shape, a layer of inner thin white, thin layer of thick white.

5. Chalazae - thin layer of thick white has fiber strands and surrounds yolk with twists at both ends called chalazae that tend to hold the yolk in center of egg.

6. Vitelline Membrane - contains the yolk. In a fresh egg the membrane is strong and the yolk stands up when the egg is broken out. Older eggs the yolk flattens out because the membrane is weakened.

7. Yolk - feed eaten by hen affects the color.

8. Germ Spot - small white spot on surface of yolk. If fertile, will develop when kept at 80°F or above.

K. Candling Eggs:

1. Candle - use a 40-watt bulb, a cylinder with hole in end, a cushion around the opening protects egg from cracking, placed at elbow height so operator will look down on egg.

2. Hold egg to light at a 45° angle with large end up, between thumb and tips of first two fingers, and twirled on its long axis.

L. Grading Eggs:

1. Shell shape and texture:

   a. Practically normal - usual shape, even texture and strength, free from rough areas or thin spots. (AA and A quality)
   b. Slightly normal - somewhat unusual shape or slightly faulty in texture or strength, no pronounced thin spots. (B quality)
   c. Abnormal - misshapen or faulty texture, show pronounced ridges, thin spots, rough areas. (C quality)

2. Shell Cleanliness:

   a. Clean - free from foreign material and stains and discoloration or with only very small specks or stains. (AA or A quality)
   b. Slightly stained - free from dirt, has slight stains 1/32 of shell surface may be slightly stained if localized, if scattered 1/16 of shell can be slightly stained. (B quality)
   c. Moderate stains - free from dirt, has stains of moderate degree covering no more than 1/4 of shell surface. (C quality)
   d. Dirty - has dirt, prominent stains over more than 1/4 of shell surface.

3. Unbroken.

4. Air cell - A Quality: must not move; B Quality: tremble, move freely or bubbly; C Quality: float or be bubbly.

5. White - A's and B's free from discolor, C's - spots less than 1/8 inch in diameter.

6. Firmness:

   a. Reasonably firm - white holds yolk fairly well in center of egg. (A quality)
   b. Slightly weak - yolk permitted to move somewhat freely. (B quality)
   c. Weak and watery yolk - swings freely and rapidly and come close to shell so plainly visible. (C quality)

7. Yolk:

   a. Fairy well-centered - stays at about center. (A quality)
   b. Off-center - is above or below center and swings close to shell when egg is twirled. (B or C quality) When yolk is almost up to air cell or down to small end the egg is C quality.

8. Yolk Outline:

   a. Fairly well defined - darkness is influenced by the yolk color as well as firmness of albumen. Less outline indicates firm albumen. (A quality)
   b. Well defined - the yolk outline is definite and distinct as egg is twirled but not dark enough to mark the exact edge. (B quality)
   c. Plainly visible - The outline is clearly visible. No blending at edges. (C quality)

9. Yolk shadow:

   a. Round (A quality)
   b. Slightly enlarge and flattened - oval shape. (B quality)
   c. Enlarged and flattened - several times wider than high. (C quality)

10. Inedible if contains black rots, white rots, mixed rots, green whites, blood rings, embryo chicks, if eggs sour, moldy or musty, have stuck yolks, bloody whites, blood or meat spots larger than 1/8 inch in diameter or are filthy, decomposed or putrid.

M. Weight Class - per dozen: Jumbo, 30 oz., Extra Large, 27 oz., Large, 24 oz., Medium, 21 oz., Small 18 oz., Peewee, 16 oz.

N. Broken Out Quality:

1. AA - Yolk is round and upstanding, thick white is egg shaped and close around yolk, thin white cover small area.

2. A - Not quite as upstanding, thick white oval shaped not clinging as closely to yolk, thin white does not spread over large area.

3. B - Yolk somewhat flattened, thick white lost oval shape and thinner, thin white spreads over large area.

4. C - Yolk flattened, thick white undistinguished from thin white spreads over large area.

5. Inedible - same characteristics as inedible class of shell grading.

TEACHING LEARNING ACTIVITIES:

1. Use the chickens from motivation. Ask the students, "What breed of chickens are displayed?" Review classification of chickens with the students.

2. Review the parts of the chicken transparency with the class.

3. Use the chickens in motivation to show students how to determine if hen is laying. Allow each student to practice examining the chickens' pelvic bones and pelvic to keep bone widths. (Show transparency)

4. Review how to determine length of time for laying by bleaching and how molting relates to laying. Select a chicken and ask students to determine how long the hen that is molting and ask students to determine if the hen is a good egg producer. (Show transparencies)

5. Have students judge a class of hens and pullets during a field trip to a poultry operation.

6. Set up a class of chickens for students to practice keeping and culling for quality.

7. Review judging poultry for meat qualities. Practice judging a class of friers, both live and dressed.

8. Exhibit the parts of an egg by breaking it out and describing the parts and functions of each part.

9. Demonstrate the candling procedure and review the grading factors to observe.

10. Set up a demonstration using eggs with different grades and have students practice grading.

11. Have students grade three or four eggs.

12. Break out eggs and grade each for the class.

13. Break out more eggs and have each student grade them.

SUGGESTED EVALUATION:

1. Grade the judging classes.
2. Quiz students over class discussion.
3. Assign grades to lab exercises. (Laying determination, egg grading)

P95

how to judge
Poultry and Eggs

Cooperative Extension Service · Purdue University · Lafayette, Indiana

This bulletin is written for you....

If you belong to a 4-H club or an FFA chapter, then this bulletin is written especially for you. Club leaders and others interested in poultry and egg judging will also find it helpful.

Why learn to judge poultry and eggs?

Anyone who can evaluate a situation, consider its different angles and reach a decision about what needs to be done is usually recognized and accepted as a leader. Judging gives you experience in leadership.

Judging also encourages you to observe accurately and to make sound decisions based on facts. It teaches you to balance one set of conditions against another and to come to a decision.

Poultry and egg judging teaches you the important points about good chickens and eggs. This knowledge will be of practical use in the selection of birds for commercial purposes, in marketing poultry and eggs, and in purchasing poultry and eggs for home consumption.

Through poultry and egg judging you will learn that the poultry industry is one of the most progressive phases of agriculture. You can find that the career opportunities for trained people are widespread. Many who are successful in poultry work today got their start in 4-H or F.F.A.

Judging is fun and a challenge, too. You can get real pleasure out of matching your judgment and decision-making against others. You will also get the thrill of accomplishment. There is competition in poultry and egg judging at the club, county and state levels. Your leader can give you more information about competitive judging.

*by Richard L. Adams and Joe G. Berry, Extension Poultrymen**

how to judge

Poultry and Eggs

Classification of Chickens

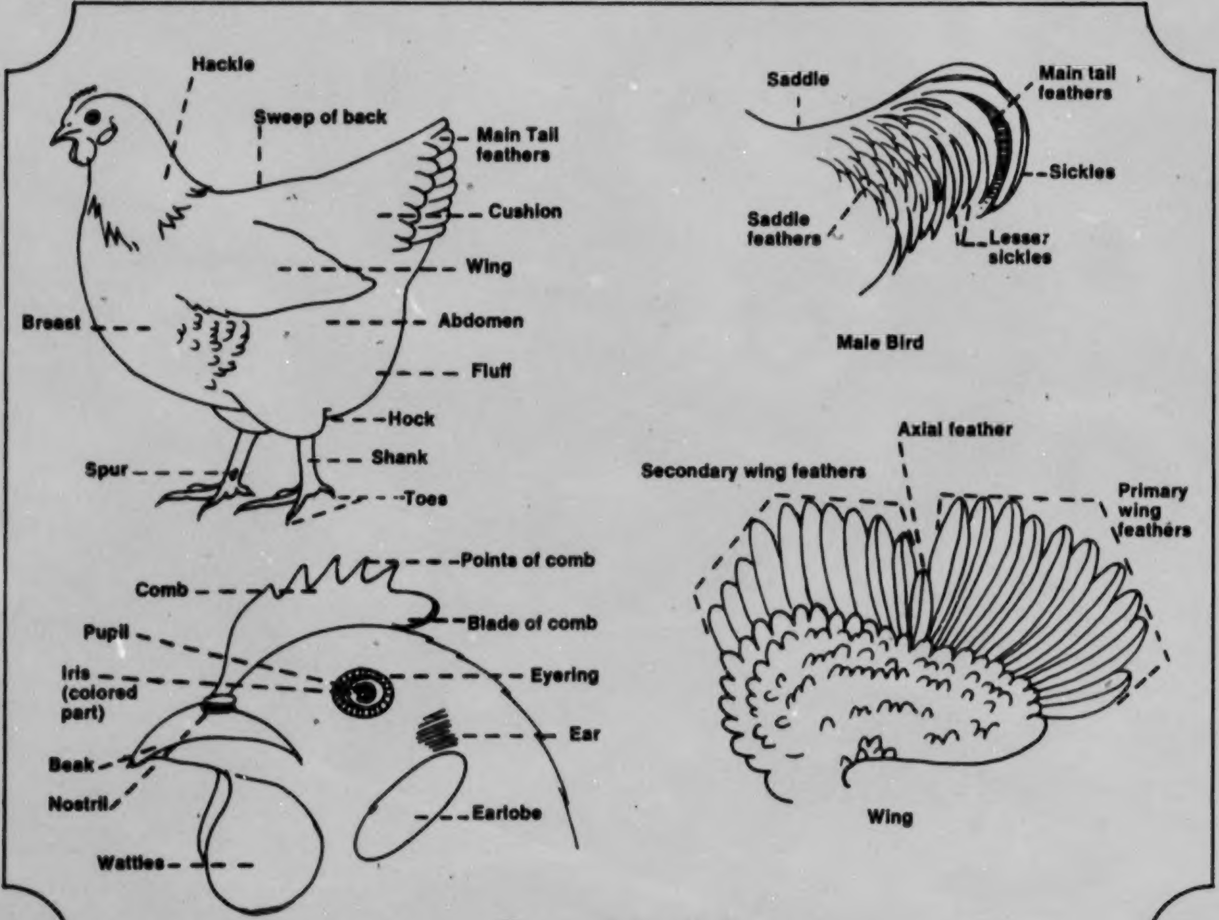
Chickens are classified by class, breed and variety.

Class is determined by place of origin.

For instance, all breeds in the **American** class originated in America; all breeds in the **Mediterranean** class originated in countries touching the Mediterranean Sea. Within each class, there are several breeds.

A **breed** is characterized chiefly by a common body shape. Plymouth Rock, Leghorn and New Hampshire are breeds.

Variety is a classification within a breed and depends upon feather color or pattern or the kind of comb.


Hackle
Sweep of back
Main Tail feathers
Cushion
Wing
Breast
Abdomen
Fluff
Hock
Spur
Shank
Toes
Saddle
Main tail feathers
Sickles
Saddle feathers
Lesser sickles
Axial feather
Secondary wing feathers
Primary wing feathers
Points of comb
Comb
Blade of comb
Pupil
Iris (colored part)
Eyering
Ear
Beak
Nostril
Earlobe
Wattles

Male Bird

Wing

The nomenclature of fowl

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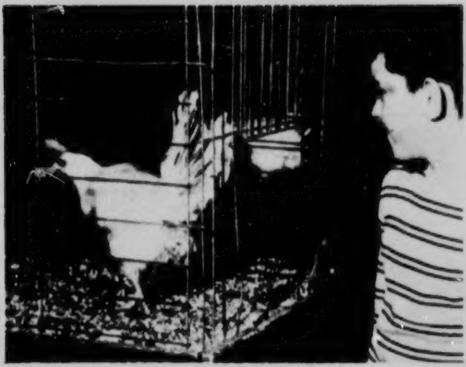
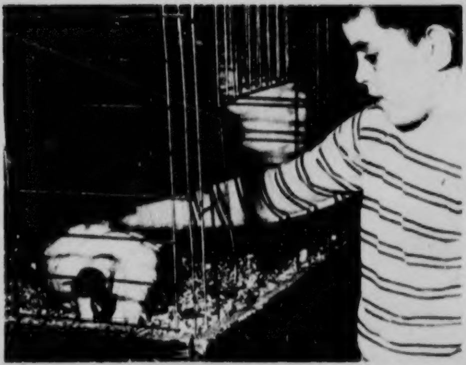
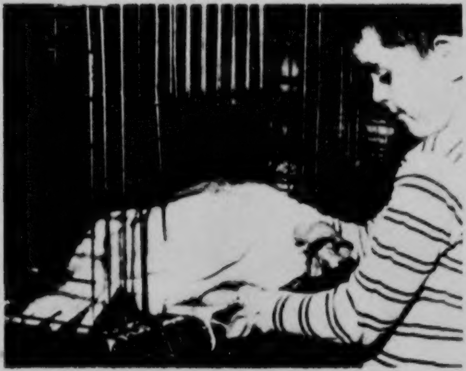
*Original manuscript prepared by Joe W. Sicer



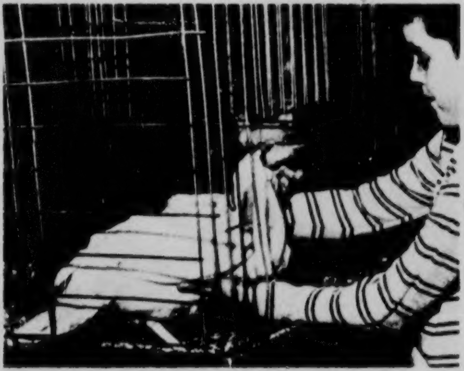
Approach the coop slowly. Maneuver the chicken until its head is facing your right.



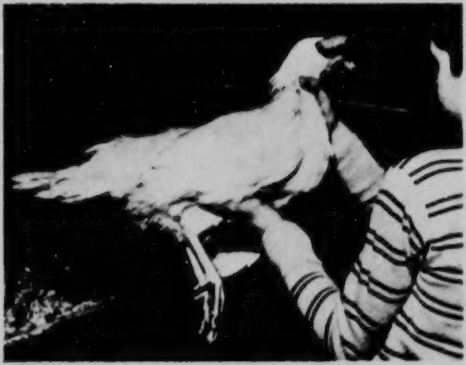
Reach your right hand over its back, grasp the opposite wing firmly, holding it so that it remains folded.



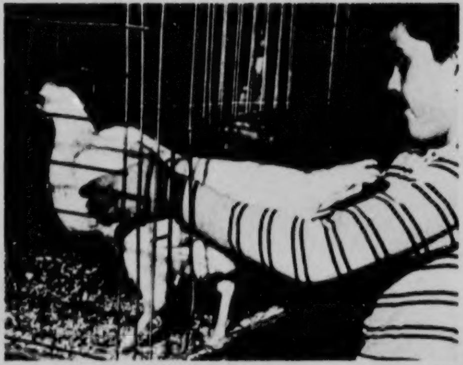
Pull the chicken toward you with its head pointed toward the coop door. With your left hand fold its right wing.



Slide your left hand, palm upward, underneath the bird's breast. Use your left thumb to hold the wing.



Lift the chicken from the coop, head first. Slide your right hand back to grasp the legs.



Always put the bird back into the coop head first. Stand with your left side to the coop and give the bird a gentle toss as you put it through the door.

Thus, there are White Plymouth Rocks, Barred Plymouth Rocks; Single Comb White Leghorns, Single Comb Brown Leghorns; Single Comb or Rose Comb Rhode Island Reds. New Hampshire has no variety.

Table 1 gives the classification of the more popular breeds and varieties. They are a few of the more than 125 varieties and 12 classes described in the American Standard of Perfection.

Breed types

Each breed of chicken has a characteristic ideal breed shape which differs from the ideal shape of any other breed. Each variety within a breed also has its ideal color or kind of comb. In addition, certain other physical characteristics, such as color of ear lobe, color of skin or shanks, presence or absence of feathers on the shanks, are definite for the breed, although the same characteristics may be common to several breeds.

The first step toward becoming a poultry judge is to learn the proper names of the important parts of a chicken. If you call a chicken's hock its "knee," anyone familiar with poultry will know you are a beginner. See the illustration for information on the important parts of a chicken.

How to handle chickens properly

Chickens must be handled carefully.

Handle the bird correctly and it will be completely under your control. The bird will feel that it is safe, will allow you to handle it, and only rarely will it try to escape. Handle one the wrong way and any good poultryman will spot you at once as an amateur. The chicken will know it too, and will probably become excited and try to get away, and may injure itself.

When judging poultry it is wise to step back and get an overall view of the birds before handling them. Then all factors should be considered, not just one thing alone.

Learn to give reasons for your placings

Even though reasons may not be called for in all contests, you will be a better judge if you can tell why you placed a

Table 1. Classification of popular breeds and varieties

Class	Breed	Variety
American	Plymouth Rock	Barred, White, Buff
	New Hampshire	No variety
	Rhode Island Red	Single Comb, Rose Comb
	Wyandotte	White, Buff
Mediterranean	Leghorn	Single Comb White, Rose Comb White Single Comb Brown, Rose Comb Brown
	Minorca	Single Comb White, Rose Comb White Single Comb Black, Rose Comb Black
English	Orpington	Buff White
	Cornish	Dark, White
Asiatic	Brahma	Light, Dark
	Cochin	Buff, Partridge

class as you did. When giving reasons, the important differences between the birds should be outlined. Examining every bird from head to foot and describing her in detail is not necessary.

Terms that apply to chickens should be used. For example, pigmentation present, the pliability of the abdomen, the distance between the pubic bones, or the alertness in the eye should be mentioned. Reasons should not sound as though they apply to a class of fat steers.

Look directly at the person who is listening to your reasons and stand squarely on your feet. Talk with conviction and assurance. This will be easy if you really saw the difference in the birds and are certain you can justify your placing.

Here is an example of a good set of reasons for a typical class. The rather formal introduction can be omitted, of course, when not giving reasons as part of competition.

"My name is John Doe. I am a member of the ____________ team.

"I place this class of White Leghorn hens 3, 1, 4, 2.

"In both No. 3 and No. 1, the pigment has almost completely faded, but No. 1 shows a tinge of pigment left in the hocks. No. 3 has a more alert expression in the eye, a slightly wider, flatter back, and the shanks are somewhat leaner and flatter than No. 1's, indicating that she has probably laid at a somewhat more rapid rate than did No. 1. Neither hen has started to molt.

"I placed No. 1 over No. 4 because No. 4 shows definite yellow in the shanks, showing that she has not laid so long as No. 1. No. 4, however, does have a full, pliable abdomen with an even wider spread between pelvic bones than No. 1.

"No. 2 is placed at the bottom of the class because she shows very little fading of the pigment from the shanks.

There is pigment returning to the beak at the corners of the mouth, the comb is beginning to dry and shrivel, and there is a spread of less than two fingers between the pelvic bones. She is, therefore, already out of production, while No. 4 is still laying. In addition, she has dropped one primary wing feather in each wing.

"For these reasons, I place this class 3, 1, 4, 2."

Judging for Egg Production

To judge how well a hen has laid during the past six months to a year, you need answers to these questions:

Is she laying now?

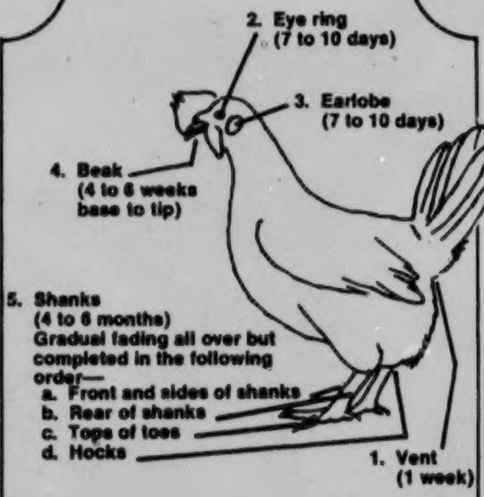
The spread between the keel and pelvic bones indicates laying condition. Three finger spread indicates production.

How long has she been laying?

If she is not laying now, when did she stop?

Did she lay at a high rate?

You can arrive at the answers with a reasonable degree of accuracy if you understand certain characteristics of good layers and the changes that occur as a hen lays or stops laying.


2. Eye ring (7 to 10 days)
3. Earlobe (7 to 10 days)
4. Beak (4 to 6 weeks base to tip)
5. Shanks (4 to 6 months) Gradual fading all over but completed in the following order—
a. Front and sides of shanks
b. Rear of shanks
c. Tops of toes
d. Hocks
1. Vent (1 week)

Note the order in which the yellow pigment fades from the hen.

How long has a hen been laying?

This is judged by the amount the pigmentation has faded. The time schedule for fading should be carefully studied. Other things being equal, the hen that is more nearly completely faded has laid the most eggs.

If the hen is not laying now, when did production stop?

If the hen has stopped laying within the last six weeks, the time when production stopped can be determined by the amount of yellow coming back into the beak at the corners of her mouth.

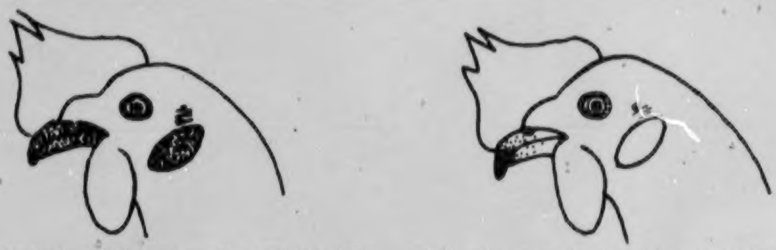
If the hen stopped laying more than six weeks ago, the length of time since production has stopped can be determined by the number of new primary wing feathers. This should always be checked against the yellow in the beak. The hen may have molted and laid, too. Usually the hen which has been out of production the longest, has laid the least.

Did she lay at a high rate?

This is especially important for judging birds when the pigment is equally faded. Judgment should be based on the speed of molt and on the physical characteristics that indicate a high rate of

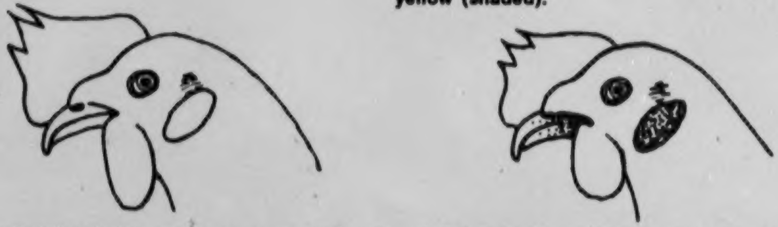
Is a hen laying now?

Laying Now		Not Laying
Red, waxy, full	**Comb**	Dull, scaly, shrinking
Large, moist, faded	**Vent**	Small, dry yellow
Soft, pliable	**Abdomen**	Hard, firm
Thin, pliable	**Pelvic Bones**	Thick, rigid
More than two fingers	**Spread between pelvic bones**	Less than two fingers
More than three fingers	**Spread from keel to pelvic bones**	Less than three fingers
Faded or starting to fade at corners of mouth	**Beak**	Yellow or turning yellow at corners of mouth



Pullet ready to lay. Note yellow pigment (shaded) in eye ring, ear lobe and all of beak.

Pullet with 2 or 3 weeks' lay. Note fading of pigment from eye ring and ear lobe. Fading of beak has progressed from corners of mouth about half way toward tip. Outer half of beak is still yellow (shaded).



Pullet that has laid 6 weeks or more. Note all yellow pigment is faded from beak.

Pullet that stopped laying 2 or 3 weeks ago. Note that yellow pigment (shaded) has returned to eye ring, earlobe and beak at corners of mouth. Tip of beak is still faded. It will take 4 to 6 weeks of no production for color to return to all of beak.

Check these four drawings for pigment changes that take place in the beak, eye ring and earlobe.

lay. Particular attention should be given to the expression in the eye.

Body changes or handling qualities

When a hen is laying, the oviduct increases in size and the body spreads and loosens to make room for the eggs to pass through the oviduct. An increased circulation of blood makes her comb appear bigger, brighter red and waxy. The vent increases in size and becomes moist and pliable to provide easy passage for the egg.

The softness and pliability of the abdomen of a laying hen can be felt with the hand. In a non-layer, the abdomen is firm and often hard. Do not confuse an abdomen that is soft because it is full of fat with one that is soft because the hen is laying.

The pelvic bones (two bones, the ends of which can be felt, one on each side of the vent) spread apart in layers to allow easy passage of the egg. You can measure this spread, and the spread from the pelvic bones to the tip of the keel bone with the fingers. In layers, the pelvic bones are usually three or more fingers apart and are thin and pliable. In non-layers they are usually thick, close together and rigid.

These changes in the abdomen do not tell you how long the chicken has laid, however. But, they do tell if the hen is in laying condition now. A good layer and a poor layer may have the same amount of spread in the abdomen. When neither is laying, both will have smaller abdomens. The size of the hen must also be taken into consideration.

To some extent, the thinness and pliability of the pelvic bones give an indication of the rate at which a hen lays. The thinner and more pliable the pelvic bones, the better the hen is laying.

Pigmentation

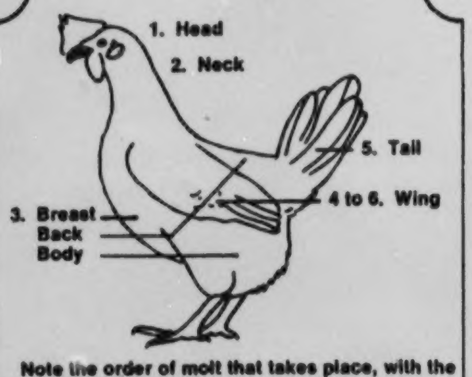
Pigmentation is the yellow color found in the beak, shanks, and skin of yellow-skinned chickens. The color is a carotenoid pigment that comes from yellow corn, alfalfa and other ingredients in the ration. Chickens with white skin, such as Orpingtons and Minorcas, do not deposit pigmentation in the skin, and no changes in their pigmentation can be seen.

A healthy, ready-to-lay pullet which has been fed yellow corn and green feeds will show yellow color in her beak, shanks, vent, ear lobes (white lobes only) and skin. As soon as she starts to lay, the pullet's yellow color gradually fades because the pigment from the feed is used in the egg yolks. This fading happens at a definite rate. However, heavy layers will fade faster than poor layers.

Length of steady laying required for complete fading

Vent	5 to 7 days
Eye ring	10 to 14 days
Ear lobes	10 to 14 days
Beak	4 to 6 weeks
Shanks	4 to 6 months

When laying stops, the color returns in the same order. It returns faster than it faded.



Note the order of molt that takes place, with the head first and the tail and wings last.

Pigmentation in the beak calls for special consideration. The color begins to fade first at the corners of the mouth and continues toward the tip of the beak. After about six weeks of laying, the entire beak is faded.

When laying stops, the color reappears first at the corners of the mouth and progresses toward the tip.

The pigmentation in the beak, therefore, can tell you (a) Is she laying now? (b) How much has she laid during the past six weeks? and (c) Did she stop laying within the past six weeks and, if so, when?

In the shanks, the color gradually gets lighter all over and disappears completely. This first occurs on the scales on the front of the shanks, then on the rear of the shanks, and, finally, from the hock and the tops of the toes. It may take as long as eight months of laying to get all the color out of the hocks and toes.

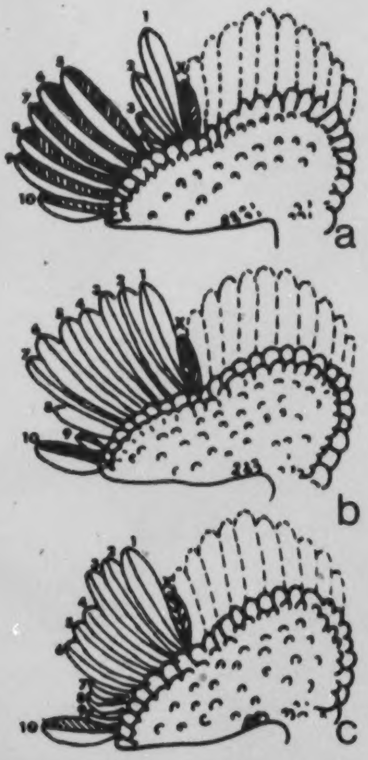
The reddish horn color on the beak and shanks of birds like New Hampshires should not be confused with pigmentation. That color does not fade with production. If it interferes with seeing the pigment in the beak, the bird's mouth can be opened and the edges of the beak checked.

Molt

Molt is important to judging because, usually, when a hen molts, she stops laying. The extent of the molt helps to answer the question, "When did this hen stop laying?" The way she molts also gives some indication about the rate at which she laid.

Neck molts and partial molts of body or wing feathers may occur at any time of the year. They indicate that the hen has probably taken a short "vacation" from laying.

A complete molt usually starts when the hen stops laying for a long period. Although some hens can molt and lay at the same time, most hens stop laying. Early molters are seldom good layers. Since the feathers are molted in a fairly regular fashion, the extent of the molt shows about how long ago a hen stopped laying.



These diagrams show wing molt. The primary feathers are numbered (1 to 10) in the order in which the feathers are normally dropped. Shaded primaries represent old feathers. Unshaded primaries are new feathers. "X" marks the axial feather. In diagram "A", a slow molt is six weeks underway. The No. 1 primary had just reached full growth. Nos. 2, 3, and 4 were dropped at two-week intervals. "B" diagram shows a slow molt nearing completion. The full-grown feathers, 1 through 7, indicate the molt has probably been in progress for 18 weeks. "C" shows a fast molt, underway for probably six weeks. The feathers were dropped in clips of three at a time.

A hen usually starts to molt the feathers from her head, neck and body before she drops any wing feathers. She sometimes continues to lay during this stage. Pin feathers on the neck or back indicate that she may go into a full molt soon and stop laying.

Spread a hen's wing open. You will note that the primary feathers and secondary feathers are separated by a smaller axial feather. (See figure .) There are ten primary feathers in all normal hens. The first one normally molted is next to the axial feather. A new quill starts at once and is grown in six weeks. In a normal, slow, early molter the second primary feather is dropped two weeks after the first one and so on until all ten have been molted. The hen with the most new primary wing feathers, therefore, has probably been out of production the longest.

How can the difference between old and new feathers be told? New feathers are usually clean, smooth and bright looking. Old feathers are often worn and frayed. In the primaries, new feathers are often broader and more rounded at the tip than the old, worn feathers.

All hens do not molt just one primary feather at a time. Fast molters drop two, three, or maybe four primaries in one "clip." Fast molters are usually fast layers, too. They are sometimes called "intense layers" because their "intensity, or rate of production" (number of eggs laid in a month) is high.

Physical characteristics indicating high rate of lay

If a hen's rate of production is high, she will usually have a well balanced, refined head. It will be moderately wide and deep with prominent eyes and a lean, clean-cut face. However, the sparkle, flash, and alert expression of the eye is a much better indication of high rate of lay than the shape of the head.

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The good layer will have a deep body, a broad back that carries its width well to the rear. Her skin will be soft, thin and pliable, and her shanks will be lean and flat.

The hen with a low rate of production will often have a long head, sometimes called a "crow head." The face may be coarse, puffy or beefy looking or, perhaps, sunken. The eye may be dull and lack that alert expression. Her body may be shallow and pinched and her back narrow and tapering. Her skin may be tight and coarse and her shanks round and full.

Keep or Cull

To cull a commercial poultry flock, a person needs to recall all that has been learned in the "Judging for Egg Production" section. It is also necessary to learn how to judge good development and maturity in pullets and how to recognize indications of disease and deformities. All of these things have a bearing on whether or not the chickens can make money as egg producers. If a person is selling hatching eggs, he should also know the important considerations about breed types. Trueness to breed characteristics and certain deformities can be inherited.

Kinds of birds to keep—desirable characteristics

Good weight.

Good body development.

No sign of disease.

No serious deformity.

Reasonably true to breed characteristics.[a]

Hens should be in production now.

Young pullets should show normal pigmentation and good maturity for age.

Kinds of birds to cull—undesirable characteristics

Excessively thin or underweight.

Poor body development.

Indication of disease, such as leukosis eye, marble bone shanks, tumors or sores on the skin, water tumor in abdomen, and a general lack of vitality.

Serious deformity, such as a badly crossed beak, severely crooked keel or back, crooked toes or legs that interfere with normal walking.

Definitely not true to breed.[a]

Hens out of production now or showing signs of only poor past production.

Pullets small and immature for their age or with abnormal paleness of shanks or beaks.

Select pullets for development and maturity

Fast growing, well developed, early maturing pullets usually make the best layers. Cull the birds that are decidedly behind the rest of the flock in size and maturity. Keep those pullets with good growth; deep, broad bodies; sturdy legs; full breasts, and early maturity.

Some indications of disease to notice when culling

Leukosis eye A misshapen pupil is a fairly definite indication of one type of leukosis. In a chicken, the normal pupil is a nearly perfect circle with a clear-cut smooth edge. With leukosis, the edge may become jagged or wavy in outline; the pupil may become oval or irregular in shape, even spindle shaped. It may become very small. The ability to expand and contract is often lacking. Gray eye, or other discoloration of the normal reddish bay iris, usually accompanies the misshapen pupil but of itself can not be considered definite leukosis.

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[a] Applies to hatching flocks.

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Marble bone shanks Another type of leukosis. The shanks are enlarged, sometimes as much as an inch in diameter, and are abnormally shaped and hard.

Tumors or sores on skin A bad blood tumor at a feather follicle, infected skin tears, or other infected sores on any part of the body should justify culling the bird from the flock.

Bumble foot This will not normally justify culling unless it is causing lameness or is swollen and feverish. Bumble foot is the result of a cut or tear in the foot which has become infected.

Water tumor in abdomen This can often be detected because of the extreme and unnatural fullness of the abdomen. It often has the feel of a full rubber hot water bottle.

Greatly enlarged crop This is evidence of a crop bound condition. Sometimes the crop is full and hard. In other cases it may be stretched so that it swings like a pendulum.

Other indications of disease A bluish comb, scabs on comb and wattles, watery eyes, running nostrils, sneezing, or a general lack of vigor and vitality, should be familiar to anyone actually culling a farm flock, but should not be included in contest. There is the possibility of carrying infections back to the home flocks. Lack of vigor is hard to detect in contest birds because all birds get worn out from the contest handling.

Deformities

Badly deformed birds should be culled from any flock because they are handicapped. A badly crossed beak interferes with proper eating. A severely crooked back or keel may interfere with the normal workings of the internal organs.

A slightly crooked beak, a slight crook in the breast or back, or crooked toes that cause no trouble in walking, often do not interfere with production and do not necessarily justify culling.

In hatchery flocks, since any deformity may be inherited, culling can be justified on even slight deformities.

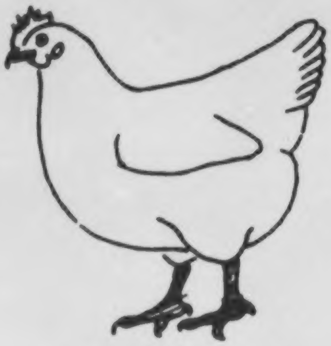
Trueness to breed type

The color or breedshape of a chicken has nothing to do with its productivity, so long as it is well developed. However, for the sake of recognition of good breeding in stock purchases, all flock owners should be familiar with important breed characteristics. When you buy pure-

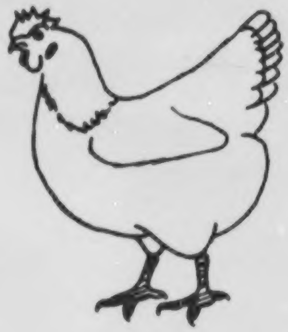
Table 3. Indications of maturity (readiness to lay eggs) in young pullets.

	Mature	Immature
Comb	Full, red, waxy	Small, undeveloped
Pelvic bones	Near three finger spread	Less than two finger spread
Beak	Faded, or starting to fade at corners of mouth	Yellow

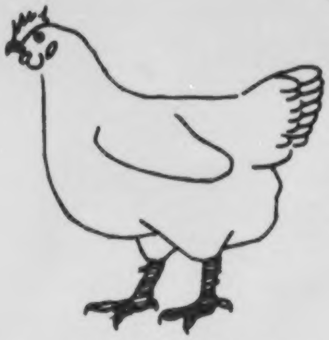
Note: A paleness in the beak and shanks of young pullets is sometimes the result of disease or parasites. It must not be confused with the normal fading of healthy, well pigmented pullets which are laying. Paleness from illness is often accompanied by a dull eye, sunken face and poor weight.



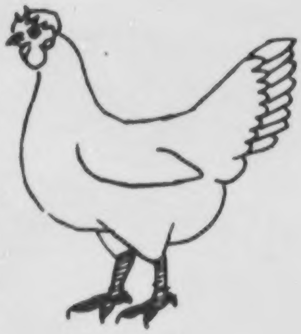
Plymouth Rocks. Their body shape is somewhat like an inverted derby hat. The back is long, nearly horizontal, but with a slight concave sweep to the tail. Comb is single and small; earlobes are red. In plumage White Rocks often show scattered gray flecks. Barred Rocks should show no red.



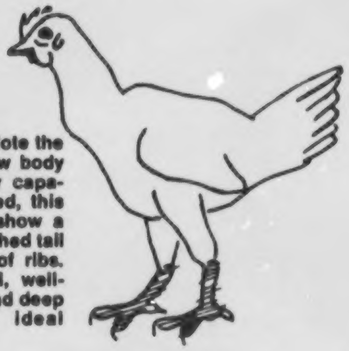
Rhode Island Reds. Their body shape is rectangular and brick shaped. The back is long and horizontal, and the tail is carried at a low angle to the back. The comb is single, small; some birds have a rose comb. Earlobes are red. Dark red feathers of the plumage are carried close to the body. Main tail feathers are black with some black in wings. White that shows in outer plumage is undesirable.



New Hampshires. Their body shape is similar to that of Plymouth Rocks, the tail is carried higher. The comb is single, medium size, and often lopped over in the females. Earlobes are red and the plumage is chestnut red (a light shade of color is preferred especially in the undercolor). The main tail feathers are black, and there's some black in the wings. White showing in the outer plumage is undesirable.



Leghorns. Their bodies are oval or egg shaped with long, sweeping curves, and are carried somewhat higher in front than in the rear. Legs, neck and tail are moderately long in relation to body. The comb is single, large, and lopped in females. Rose comb varieties are not common. Earlobes are white and plumage fits close to the body.



Cull this kind. Note the flat breast, shallow body and lack of body capacity. When handled, this bird would also show a narrow back, pinched tail and little spring of ribs. Contrast with full, well-rounded breast and deep bodies of the ideal shapes.

breds, you should expect to get purebreds. Do not expect perfection, but the birds should be reasonably true to type.

In hatchery flocks, standards of trueness to breed type vary with hatcheries, just as standards about deformities vary. Usually, only birds decidedly not true to breed will be culled.

Birds should be culled for such conditions as a New Hampshire or other heavy breed with the shape of a Leghorn; a White Leghorn with a salmon colored breast; White Rock with dark green shanks; Rhode Island Red with many white feathers; or other major variations from breed characteristics.

The minor standard disqualifications such as side sprigs, stubs or down between the toes, white in red ear lobes, or slipped wings do not usually justify culling from commercial hatchery flocks.

Keep or Cull Class

Bird No.	Keep	Cull	Reason for Culling
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

1. Leukosis eye
2. Pigment around vent
3. Pigment at the base of the beak and around the vent
4. Pigment in the eye ring, beak, and around the vent.
5. Pubic bones close together (less than 2 fingers spread)
6. Little spread between the keel and pubic bones (less than 3 fingers)
7. Vent is small, dry, and pigmented
8. Abdomen is hard and firm
9. Not true to breed
10. Immature for age
11. Very thin
12. Sick or diseased (other than leukosis)
13. Crossed beak
14. Crooked keel or back
15. Signs of poor past production
16. Crooked toes and legs that interfere with normal walking

Keep or cull placing card

This card is similar to the one used in Indiana poultry judging contests. The reasons for culling that are listed will appear on the back of the judging card. When judging the keep or cull class, each contestant should indicate with a check in the appropriate square whether the bird is to be kept or culled, the number(s) of the reason(s) for culling should be indicated in the reason column.

Judging Live Poultry for Meat Qualities

When judging live poultry for meat qualities one is trying to estimate which bird has the highest proportion of good meat, will clean the easiest and will look the best after it is dressed.

The degree of fleshing on the breast is most important, first, because it is a good indication of the fleshing on the rest of the bird and, second, because the white breast meat is the choice meat for most people. It is essential that you learn to hold each bird in a class in exactly the same position when feeling the breast. When birds are held in different positions, their breasts may not feel the same.

Fleshing

Poultry should be well covered with flesh, especially over the breast, thighs, and legs. Fleshing over breast should give a well rounded appearance and extend well forward over the wishbone.

Feathering

All feathered portions of the body should be covered with fully developed feathers. Bare backs, or backs covered only with small pinfeathers, or broken or stubby feathers, are particularly objectionable. The presence of many pinfeathers so small as to hinder clean picking elsewhere on the body, or the absence of feathers on exposed areas of the body, are also defects.

Body shape

The body should be compact, with broad breast, long straight keel bone, relatively short legs; and free from deformities. A slight crook or dent in the breastbone is undesirable, but is not a serious defect unless it is bad enough to cause an unappetizing appearance.

Finish

This pertains to the amount of fat distributed throughout the flesh, as indicated by the appearance of fat under the skin. Finish can usually be observed by separating the feathers along the breast, the thigh, and under the wing. In a well-finished bird, the fat will be well-distributed. The dark flesh will not show through the skin. It is to be expected that hens will have more fat or finish than fryers.

Freedom from defects

Market poultry should be free from unsightly defects. Breast blisters, sores, tears, bruises, sunburn, and tumors are all serious, depending upon their extent and the portion of the body affected. Frequently, such defects, if bad, can throw an otherwise good bird to the bottom of the class. Anything marring the appearance of the breast is much more serious than a defect on the back. Any indication of disease is discounted. An excessive amount of fat in the abdomen of hens is also undesirable.

Judging and Grading

Dressed and ready-to-cook poultry

In judging dressed and ready-to-cook poultry, the same principles apply as when you judge live poultry. The big difference is that you can now see the birds more clearly and the presence or absence of such defects as bruises, sores and tears takes on more importance. "Dressed" means killed, and

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SUMMARY OF SPECIFICATIONS FOR STANDARDS OF QUALITY FOR INDIVIDUAL CARCASSES OF READY-TO-COOK POULTRY AND PARTS THEREFROM[a]

(Minimum Requirements and Maximum Defects Permitted)

FACTOR	A QUALITY	B QUALITY	C QUALITY
CONFORMATION:	Normal	Moderate deformities	Abnormal
Breastbone	Slight curve or dent	Moderately dented, curved or crooked	Seriously curved or crooked
Back	Normal (except slight curve)	Moderately crooked	Seriously crooked
Legs and Wings	Normal	Moderately misshapen	Misshapen
FLESHING:	Well fleshed, moderately long, deep and rounded breast	Moderately fleshed, considering kind, class and part	Poorly fleshed
FAT COVERING:	Well covered—especially between heavy feather tracts on breast and considering kind, class and part	Sufficient fat on breast and legs to prevent distinct appearance of flesh through the skin	Lacking in fat covering over all parts of carcass
PINFEATHERS:			
Nonprotruding pins and hair	Free	Few scattered	Scattering
Protruding pins	Free	Free	Free

EXPOSED FLESH:[1] Carcass Weight Minimum	Maximum	A Breast and Legs	A Elsewhere	A Part	B Breast and Legs[2]	B Elsewhere[2]	B Part	C
None	1½ lbs.	None	¾"	(Slight trim on edge)	¾"	1½"	(Moderate amount of the flesh normally covered	No Limit
Over 1½ lbs.	6 lbs.	None	1½"		1½"	3"		
Over 6 lbs.	16 lbs.	None	2"		2"	4"		
Over 16 lbs.	None	None	3"		3"	5"		
DISCOLORATIONS:[3]								
None	1½ lbs.	½"	1"	¼"	1"	2"	½"	No Limit[4]
Over 1½ lbs.	6 lbs.	1"	2"	¼"	2"	3"	1"	
Over 6 lbs.	16 lbs.	1½"	2½"	½"	2½"	4"	1½"	
Over 16 lbs.	None	2"	3"	½"	3"	5"	1½"	

FACTOR	A QUALITY	B QUALITY	C QUALITY
Disjointed bones	1	2 disjointed and no broken or	No limit
Broken bones	None	1 disjointed and 1 non-protruding broken	No limit
Missing parts	Wing tips and tail[5]	Wing tips, 2[illegible] wing joint and tail	Wing tips, wings and tail
FREEZING DEFECTS: (When consumer packaged)	Slight darkening over the back and drumsticks. Few small ⅛" pockmarks for poultry weighing 6 lbs. or less and ¼" pockmarks for poultry weighing more than 6 lbs. Occasional small areas showing layer of clear or pinkish ice.	Moderate dried areas not in excess of ½" in diameter. May lack brightness. Moderate areas showing layer of clear, pinkish or reddish colored ice.	Numerous pockmarks and large dried areas.

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[1] Total aggregate area of flesh exposed by all cuts and tears and missing skin.

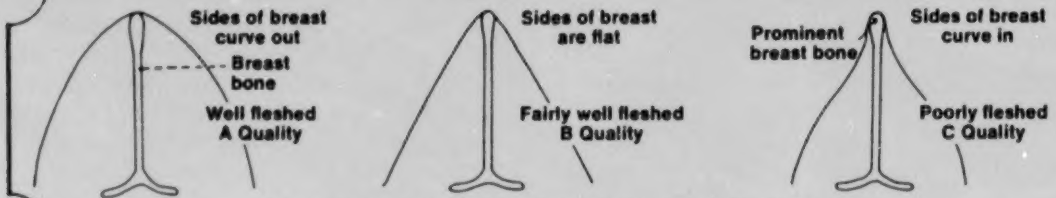
[2] A carcass meeting the requirements of A quality for fleshing may be trimmed to remove skin and flesh defects, provided that no more than one-third of the flesh is exposed on any part and the meat yield is not appreciably affected.

[3] Flesh bruises and discolorations such as "blue back" are not permitted on breast and legs of A quality birds. Not more than one-half of total aggregate area of discolorations may be due to flesh bruises or "blue back" (when permitted), and skin bruises in any combination.

[4] No limit on size and number of areas of discoloration and flesh bruises if such areas do not render any part of the carcass unfit for food.

[5] In geese, the parts of the wing beyond the second joint may be removed, if removed at the joint and both wings are so treated.

[a] Prepared by the Agriculture Marketing Service, United States Department of Agriculture.



Here compare degrees of fleshing in A, B and C quality chickens.

bled, with the head, feet, feathers, and viscera removed.

In some contests, dressed or ready-to-cook poultry are not judged by comparison, but the contestants grade the birds according to the standards of quality set up by the U.S. Department of Agriculture.

Three classifications or U.S. grades are used in the trade. They are A-Quality, B-Quality, and C-Quality. Birds not good enough for C-Quality, or birds unfit for human consumption, are called rejects. An understanding of grades is helpful in judging by comparison.

The U.S. Standards of quality are based on (1) conformation (2) fleshing (3) fat covering (4) freedom from pinfeathers (5) freedom from exposed flesh and disjointed and broken bones (6) freedom from discolorations of skin and from flesh blemishes and bruises and (7) freedom from freezer burn.

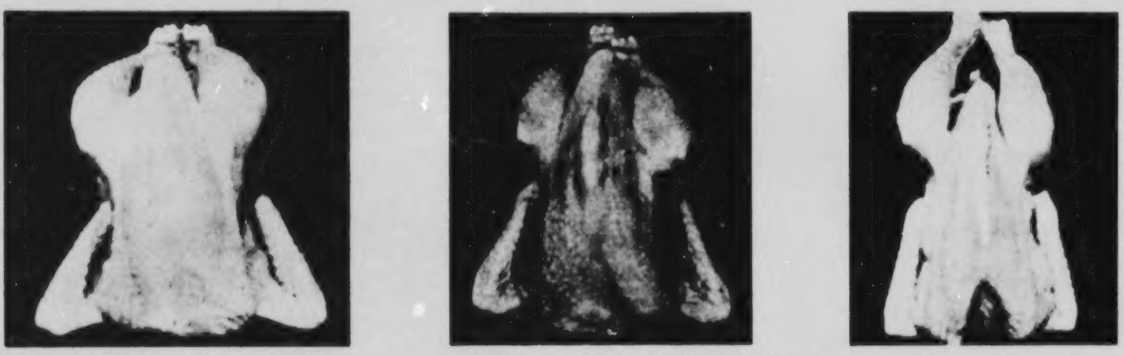
Table 4 sets forth the minimum requirements and the maximum defects permitted for A, B and C quality. For more details see the Agricultural Handbook No. 31, "Poultry Grading Manual," published by U.S.D.A. You can obtain it from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Comments on grade requirements

Conformation This refers to the presence or absence of deformities of the skeleton. A carcass is considered normal, or A-Quality, even though it has a slightly curved breastbone or a dent in the breastbone that is not more than ⅛ inch.

A practically normal, or B-Quality carcass, may have a more dented, curved or crooked breastbone or moderately crooked back or misshapen legs or wings so long as these deformities would not disturb carving the meat.

An abnormal, or C-Quality, can really be crooked. It may have an "S" shaped breastbone, badly crooked back, legs or wings. There is no limit so long as the bird is fairly well fleshed.



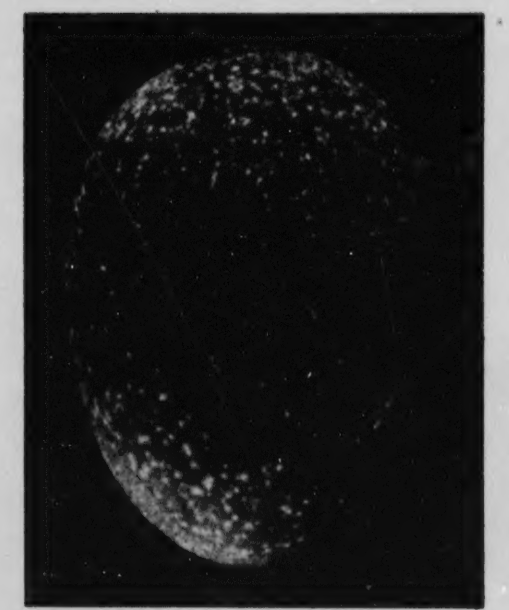
Remember that the lowest quality rating for any of the seven grading factors sets the classification for the whole bird.

Fleshing This refers to the amount of meat on the bird and is really one of the most important factors in grading. Fryers cannot be expected to be as well fleshed as hens, of course, but in general the terms "well fleshed," "fairly well fleshed" and "poorly fleshed," can be considered to mean the amount of fleshing over the breastbone needed to give the appearance shown in the cross section drawings.

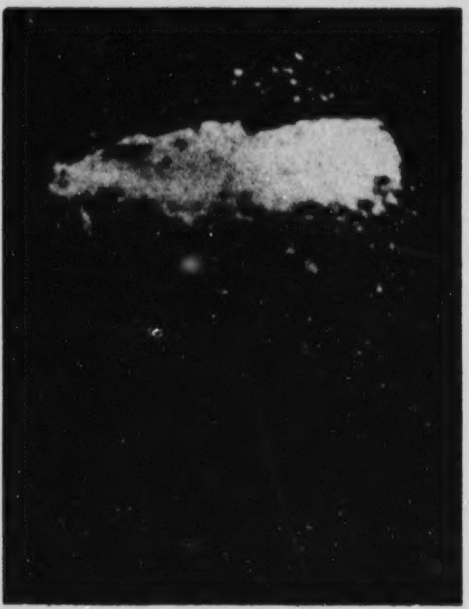
Fat covering The degree of fat or "finish" is important because it affects the appearance, flavor and tenderness of the bird. In a well-finished bird, cream colored fat can be seen in the skin and between the skin and the flesh. One good place to look is in the two main feather tracts on each side of the body. There is also a "fat collar" around the crop sac area at the front part of the breast. The middle of the back is usually the last place where a layer of fat is put on. Judging the amount of fat that is desired is somewhat complicated by the fact that a well-finished fryer may appear to have less fat than a well-finished hen. Grade A hens cannot have an excess of abdominal fat.

Freedom from pinfeathers Even C-Quality ready-to-cook chickens must be free of protruding pin feathers. A few scattered pinfeathers under the skin are permitted in B and C-Quality.

Freedom from discoloration of skin and from flesh blemishes and bruises Poor bleeding will give a reddish color to the skin because of the blood left in the veins. A slight reddening in the feather follicles on the neck and on the wings only is permitted in A-Quality birds. The discoloration can be a bit worse on B-Quality. If bad, the bird is a C.



This egg has a great deal of mottling. These spots often look like grease spots when the egg is seen away from the candle. The mottling here is not quite enough to throw the egg into "C" quality.



This egg has a mottled shell which is severe enough to be called a "C" grade.

Blemishes and abrasions on the skin, which are the result of rough handling during dressing, are not serious because they do not show objectionably if the skin is kept moist.

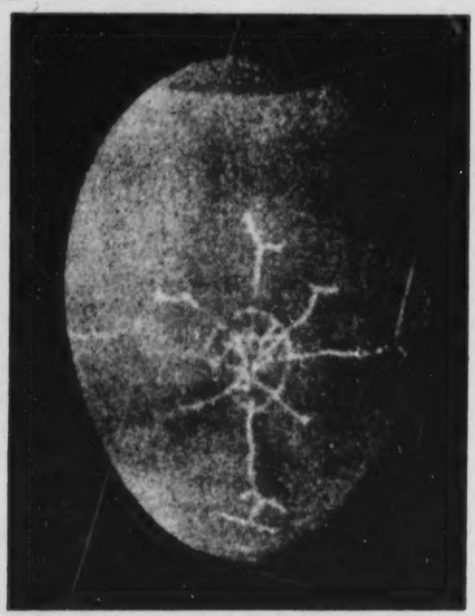
Bruises that occurred before dressing, often the result of rough handling when the birds were caught and placed in the coop, are important quality factors. Flesh bruises are much more objectionable than skin bruises. You can tell the difference by moving the skin slightly with your finger. If the bruise moves also, it is in the skin. If the bruise does not move when you move the skin, it is in the flesh.

The small flesh bruises permitted in A-Quality carcasses (none is permitted on the breast) can be only slightly reddened. Flesh bruises permitted on B-Quality carcasses can be slightly darkened. In C-Quality the flesh bruise can be somewhat dark but it must not be so bad as to make any part of the carcass unfit for food. Blue or green bruises throw the carcass into the reject or inedible category.

Freedom from cuts, tears, and broken bones Cuts and tears in the skin permit the flesh to dry out. While some broken bones are allowed, as indicated in the table, notice that there must be no accompanying bruise or blood clot. Note the variations in size of cuts and tears and extent of broken bones permitted in the different grades.

Freedom from freezer burn Freezer burn is the condition that develops when frozen carcasses are not protected from drying out. Light colored, round, slightly raised spots about ⅛ inch in diameter develop. They may be scattered in slight cases or run together over large areas in severe cases.

This is a body check. Note the line where the shell was cracked but healed over before egg was laid.



This egg has a cracked shell. The cracked area is easy to see in this case, but may not be so easily detected in all cases.

Rejects A carcass with any of the following conditions shall be excluded from any grade:

1. Decomposed.
   (a) Slippery or slimy condition of the skin. (b) Greenish cast over the back and between the thigh and rib. (c) Mold growth anywhere on the bird. (d) Putrid off-color. (e) Green vent or green areas surrounding vent.
2. Extreme emaciation.
3. Birds that are bruised or mangled in excess of the amount permitted in C quality.
4. Birds showing obvious external evidence of disease (feverish). The skin and flesh of such birds are darker than normal.
5. Birds with tumors (internal or external) or with sores or exterior scabs (including breast blisters). A breast blister sac may be removed provided the entire sac is removed, and the carcass considered for B or C quality.
6. Anemic (the abnormally pale carcass).
7. Birds with parts or meat missing other than indicated in the table.

Combining all grading factors

To place a bird in its proper quality classification, remember that the lowest quality rating for any of the above seven grading factors set the classification for the whole bird. Thus, a bird may be of A-Quality in conformation, fleshing, fat covering and tears; B-Quality in pinfeathers; but C-Quality in bruises. The proper classification for such a bird would be C-Quality.

Candling and Grading Eggs

A knowledge of the structure of an egg is essential to an understanding of candling and grading.

The **bloom** or **cuticle** is a protective covering over the shell. When it is rubbed off, either in washing or in dry cleaning, bacteria and mold find a much more ready access to the interior of the egg.

The **shell** is mostly lime. It has thousands of small openings or pores which permit "breathing" by the developing chick embryo and through which the moisture inside the egg can evaporate. Not all shells are normal. Some are very thin and rough. Others are ridged and poorly shaped. Any of these shell defects lowers the grade of the egg.

Two membranes line the inside of the shell. During the formation of the egg, the membranes are present before the shell is produced. When the egg is first laid, and is still warm, the contents entirely fill the shell. As the egg cools, the contents shrink and air is drawn in through the pores of the shell. The membranes separate (usually at the large end of the egg) and the air cell is formed between the membranes.

The **air cell** of a newly laid egg is very small, about the size of a dime. As evaporation of water from the contents takes place with aging or exposure to dryness or heat, the air cell does not move in the egg but if the two membranes separate easily, a "tremulous" or even a "floating" air cell results. If the inner membrane breaks, one or more separate air bubbles may float freely in the egg. Such are called "bubbly" air cells.

The **egg white or albumen** of a newly laid egg appears to have two parts—the thick and the thin albumen. Actually, there are four parts within. Just inside of the shell membrane is the layer of the outer thin white. Then comes the firm, or thick white, which in the fresh egg makes up about 55 per cent of the albumen. This thick white is inclined to hold an egg shape, even when the egg is broken out. A layer of inner thin white is enclosed within the thick albumen and finally, surrounding the yolk, is a thin layer of thick white consisting of fibrous strands. This layer surrounds the yolk as a paper wrapper surrounds a candy kiss and is twisted at both ends to form white cords called chalazae.

The **chalazae** act like drag anchors in the thick albumen and tend to hold the yolk in the center of the egg, protecting the germ cell.

The **vitelline membrane** contains the yolk. In a fresh egg this membrane is strong and the yolk "stands up" in the broken-out egg. With age, or improper holding conditions, the vitelline membrane weakens and stretches as water is absorbed from the albumen into the yolk. The yolk then becomes enlarged and flattened.

The **yolk** varies in color, depending upon the feed eaten by the laying hen. Yellow corn in the ration results in deep yellow yolks. Those hens eating a high proportion of oats or wheat produce lighter colored yolks.

The **germ spot or germicidal disc** is the small white spot on the surface of the yolk. It is present whether or not the egg is fertile. At temperatures above 80°, if fertile, the spot begins to grow to form a chick.

Grading eggs

Grading eggs is the process of sorting them according to interior quality, egg size or weight, and shell quality. Shell color is not considered in grade specifications, but eggs are often sorted according to color, and in some markets it is a definite price factor.

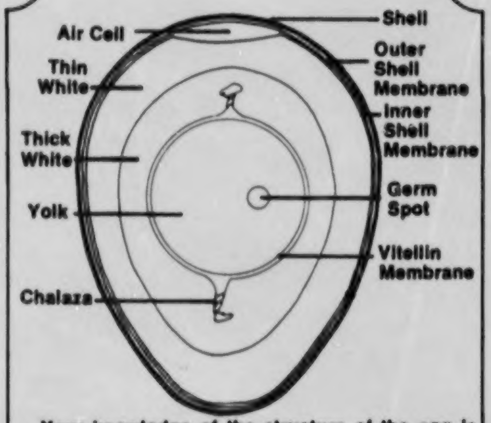
The standards for grading are defined in the USDA Agriculture Handbook No. 75, "Egg Grading Manual".

Candling is used to judge interior quality. In a darkened room, when an egg is held against a small hole through which a bright light shines, it is possible to estimate how the egg will look when broken out.

The candling light must be neither too dim nor too bright. A 40-watt bulb is right, with a good reflecting surface inside the candle. A 60-watt bulb is enough otherwise. There are many different makes of commercial candles. Satisfactory ones can be homemade. The size of the candle opening, the relation of the bulb to the opening and the relation of the light to the operator are all important. A cushion around the candle opening cuts down the danger of cracking eggs. It also allows the egg to fit the opening better so that light will not leak around the egg.

The light should be at elbow height so that the operator looks down on the egg instead of directly into the light. It is helpful if there is either a hole or a black surface in the bottom of the candle, so positioned that when the egg is taken away from the light the operator is not partially blinded by bright reflected light.

The egg should be held to the light at an angle of about 45 degrees, with the large end of the egg up. It should be held be-



Your knowledge of the structure of the egg is essential to an understanding of candling and grading.

tween the thumb and the tips of the first two fingers and twirled gently on its long axis. This causes the contents of the egg to move so that the action of the yolk shadow against the shell can be observed. At the same time, the size of the air cell can be noted and any blood or meat spots may be brought into view.

In a high quality egg the yolk is held in the center of the egg because of the abundance of the thick white and the stabilizing action of the dragging chalazae. Therefore, the yolk makes a comparatively dim shadow and there is not much movement of this shadow.

In lower quality eggs the thick white becomes increasingly thinner. It, therefore, offers less resistance to the chalazae and as a result, the yolk is allowed to swing closer to the shell when the egg is twirled. This makes a darker, more plainly visible shadow with a more distinct outline. You get the same result by holding a ball close to a wall and then moving it further away. Try it and notice the change in the sharpness of the shadow outline.

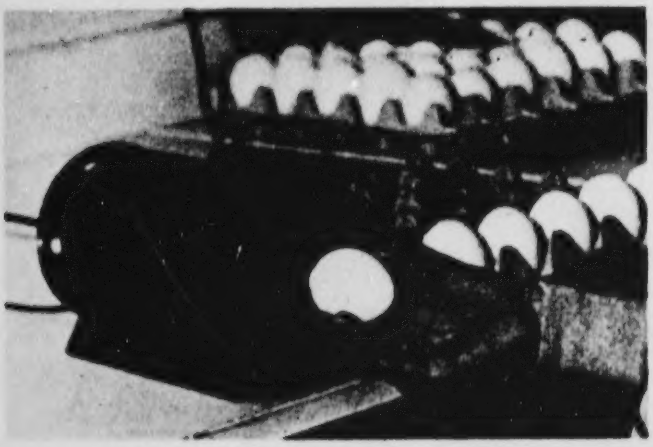
The yolk shadow also moves more freely and faster in low quality than in high quality eggs. Some hens lay eggs that have only a small amount of thick white when laid. Such eggs would grade down when candled, even though freshly laid.

The yolk may also lose its center position vertically as the albumen thins. In addition, it may become enlarged and flattened.

Shell texture and shape are also considered, along with interior quality, when grading eggs. Abnormally shaped eggs, or eggs with thin, weak shells are graded down. Two terms used in describing shell texture need special explanations. A body check is a healed over, cracked or broken shell usually observed as a pronounced ridge encircling the egg. When held before a candle, the healed-over cracks can be seen.

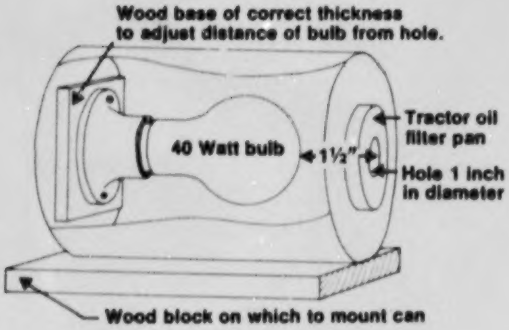
Mottling is the presence of small spots in the shell, varying from the size of a pin point to about ⅛ inch in diameter. Sometimes the spots merge together. Away from the candle, the spots appear somewhat like small grease spots. Before the candle, they are quite readily seen, since they let more light through than the rest of the shell. They are the result of an uneven distribution of moisture in the shell and are influenced by the relative humidity in the holding room.

When classifying eggs as to AA, A, B, or C-Qualities all of the above conditions are considered. A description of the standards for each of these qualities is given in this manual. AA is not used in



Hold the egg between the thumb and first two fingers, with the large end toward the candle at an angle of about 45 degrees.

Indiana contests. Instead, AA and A Quality are combined and are all called "A."


Wood base of correct thickness to adjust distance of bulb from hole.
Tractor oil filter pan
40 Watt bulb
1½"
Hole 1 inch in diameter
Wood block on which to mount can

You can make a satisfactory egg candle at home from a tin can that's about 5 inches in diameter and 7 to 9 inches long. A shortening can with an easily removable lid works well.

Exterior Quality

Shell shape and texture

The specifications of the United States standards provide three degrees of variation:

Practically normal A shell that approximates the usual shape and that is of good, even texture and strength and free from rough areas or thin spots. Slight ridges and rough areas that do not materially affect the shape, texture, and strength of the shell are permitted. (AA and A-Quality.)

Slightly abnormal A shell that may be somewhat unusual in shape or that may be slightly faulty in texture or strength. It may show definite ridges but no pronounced thin spots or rough areas. (B-Quality.)

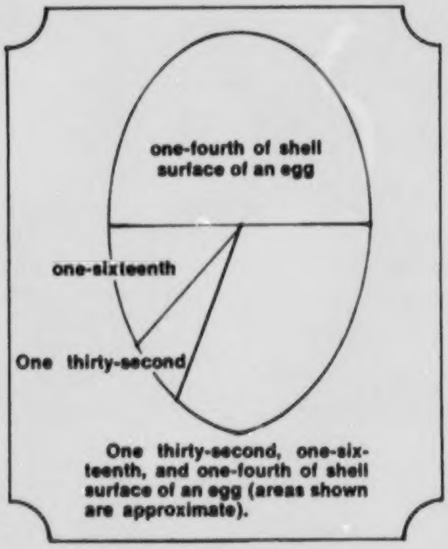
Abnormal A shell that may be decidedly misshapen or faulty in texture or strength or that may show pronounced ridges, thin spots, or rough areas. (C-Quality.)

Classification of shell cleanliness

Freedom from stains and foreign material on the shell of eggs must be considered when assigning a quality designation to an individual egg. The following terms are descriptive of shell cleanliness:

Clean A shell that is free from foreign material and from stains or discolorations that are readily visible. An egg may be considered clean if it has only very small specks or stains, if such specks or stains are not of sufficient number or intensity to detract from the generally clean appearance of the egg. Eggs that show traces of processing oil on the shell are considered clean unless otherwise soiled. (AA and A-Quality.)

Slightly stained A shell that is free from adhering dirt, but which has slight stains which do not appreciably detract from the appearance of the egg. When the stain is localized, approximately 1/32 of the shell surface may be slightly stained, and when the slightly stained areas are scattered, approximately 1/16 of the shell surface may be slightly stained. (B-Quality.)



One thirty-second, one-sixteenth, and one-fourth of shell surface of an egg (areas shown are approximate).

Eggs having more than 1/16 of the shell surface slightly stained may be classified as C-Quality.

Moderate stains A shell that is free from adhering dirt, but which has stains of moderate degree covering not more than ¼ of the shell surface. (C-Quality).

Dirty The shell must be unbroken with adhering dirt, or foreign material, prominent stains, or moderate stains covering more than ¼ of the shell surface.

The illustrations of shell cleanliness are intended as a guide and are not to be used as an actual measurement in grading. Graders should learn to determine the area that constitutes these measurements and then judge eggs having soiled shells against this mental picture.

It is difficult to visualize the gathering of soiled areas and apply them against a scale. However, if the grader keeps in mind that the total area of a normal 2-ounce egg is about 10½ square inches, 1/32 of the shell surface of a 2-ounce egg would measure approximately ⅜" x ⅜"; 1/16 would measure about 13/16" x 13/16"; and ¼ of the shell surface would measure a little more than 1½" x 1½".

Terms Used in Quality Standards

Shell—clean In actual practice, dirty eggs are not graded. They are classed as dirty. In judging contests, cleanliness must be disregarded because the eggs could easily become soiled from handling.

Unbroken Only eggs with unbroken shells are classified as AA, A, B or C Quality. Others are classed as checks or leakers depending upon the extent of the break.

Practically normal (A) A shell that is close to the usual shape and is free of thin spots and rough areas. Slight ridges or roughness that do not affect strength of shell are permitted.

Slightly abnormal (B) They may be quite round or have no distinct big and little ends. They must not be too long to fit into an egg case filler. There can be definite ridges but no pronounced ridge as is common with a body check. They can have some thin or rough areas but must not approach being so weak that a tap with your fingernail would break them. There can be some mottling.

Abnormal (C) They can be definitely misshapen, lopsided or long and narrow, and may have ridges and body checks. They can show numerous large mottling spots, or definite large, thin spots or rough areas, but must not be cracked.

Air Cell The depth is measured along an imaginary line that runs from the shell perpendicularly to the air cell line.

Movement In grade A the air cell must not move. In B's it can tremble or even move freely. It can even be bubbly. In C's, it can float or be bubbly.

White—clear This refers to freedom from any discoloration, such as a green white or bloody white and freedom from foreign bodies such as blood or meat spots. Spots less than ⅛ inch in diameter are permitted in C-Quality eggs. Prominent chalazae should not be confused with spots. Look for the spot of light that often can be seen along with a chalaza.

Reasonably firm (A) The firmness or weakness of the white is gauged by the action and location of the yolk when the egg is twirled. When reasonably firm, the white holds the yolk fairly well in the center of the egg.

Slightly weak (B) The yolk is permitted to move somewhat freely, and may swing close enough to the shell so that the yolk outline is well defined; the yolk may float above the center of the egg.

Weak and watery (C) The yolk may swing quite freely and rapidly. It may come so close to the shell that the shadow is plainly visible; the yolk may float high against the air cell.

Yolk—Fairly well centered (A) The yolk stays about in the center of the egg instead of floating closer to the big end or sinking toward the small end. A rise or fall of not more than one-fourth of the distance to the ends is permitted. When the egg is twirled, the yolk swings away from its normal central location not more than one-half of the distance toward the sides of the egg.

Off center (B or C) The yolk is definitely above or below center and swings close to the shell when the egg is twirled. Generally when the yolk is almost up to the air cell, or is down in the small end of the egg, the egg is C-Quality.

Outline fairly well defined (A) The degree of sharpness of the yolk shadow outline is a very important factor in classifying eggs. The darkness of the yolk shadow is not so important except when it is very dark as in low C-Quality eggs. The darkness is influenced by the color of the yolk itself as well as by the firmness of the albumen. Because of the greater contrast between yolk shadow and the shell of white eggs, inexperienced candlers are often inclined to classify white eggs lower, relatively, than they do the same quality brown eggs. Careful observation of the outline of the shadow should overcome this tendency.

Well defined (B) The outline of the yolk shadow is quite definite and distinct as the egg is twirled, but it is still not so sharp that you could definitely mark the exact edge.

Plainly visible (C) The outline is clearly visible. There is practically no blending at the edges. You could mark with a pencil the edge of the yolk shadow.

Slightly enlarged and flattened (B) The yolk shadow has taken on an oval shape instead of remaining round. This is because the vitelline membrane has weakened somewhat.

Enlarged and flattened (C) The yolk shadow is definitely flattened out, maybe several times wider than high. This is because the yolk has absorbed moisture from the white, and the vitelline membrane has weakened and stretched.

Eggs are classed as inedible if they contain black rots, white rots, mixed rots, green whites, blood rings, embryo chicks (at or beyond the blood ring stage); if the eggs are sour, moldy or musty; have stuck yolks, bloody whites, blood or meat spots larger than ⅛ inch in diameter, or are filthy, decomposed or putrid.

Blood and meat spots are usually found on or close to the yolk. Mold growth under the shell can be seen as a distinct dark spot. A fertile germ spot that started growth and then died would show up as a ring of blood.

In A-Quality, the yolk shadow can be seen, but the edges blend off into the white so that it is hard to tell where the shadow starts or where it stops. It is just "fairly well defined."

Egg size In addition to grading eggs on quality, grading is also done on weight. Six weight classifications are recognized:

Weight classifications

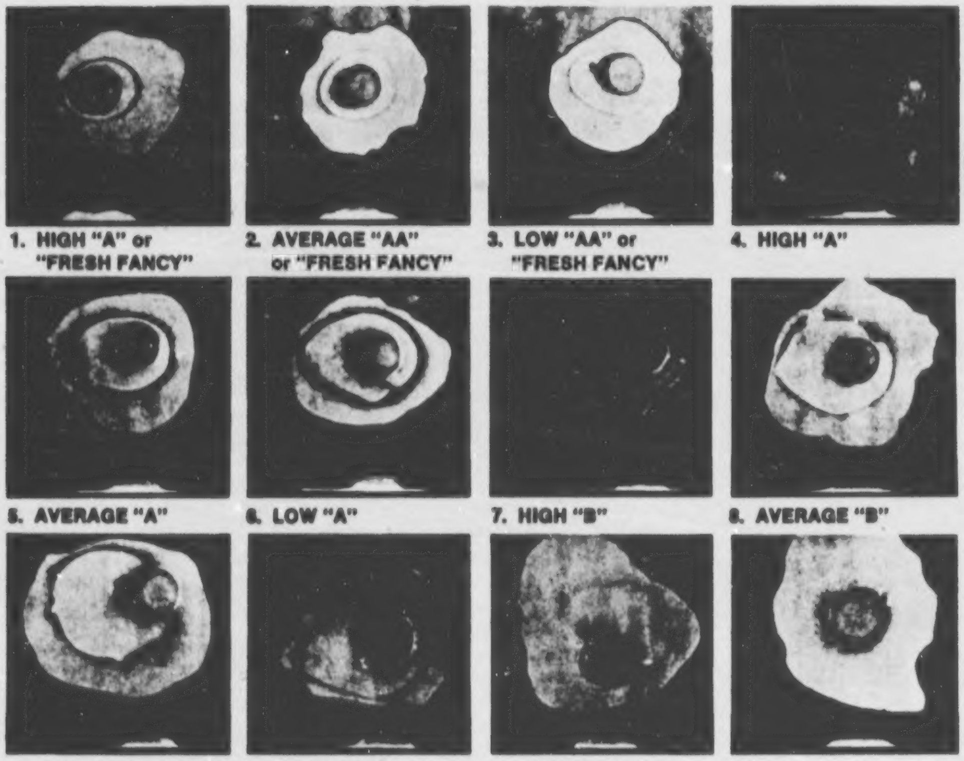
	Average weight per dozen (ounces)
Jumbo	30
Extra Large	27
Large	24
Medium	21
Small	18
Peewee	15

Grade **letters** have nothing to do with the egg weight. Grade A eggs, for instance, may be of any size.

In Indiana judging contests, eggs are not sorted for size by the contestants.

More detailed information on egg grading can be obtained from Agricultural Handbook No. 75, "Egg Grading Manual." It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Color charts of U.S. Standards for Quality of Individual Shell Eggs, showing the


1. HIGH "A" or "FRESH FANCY"
2. AVERAGE "AA" or "FRESH FANCY"
3. LOW "AA" or "FRESH FANCY"
4. HIGH "A"
5. AVERAGE "A"
6. LOW "A"
7. HIGH "B"
8. AVERAGE "B"
9. LOW "B"
10. HIGH "C"
11. AVERAGE "C"
12. LOW "C"

Interior Quality of Eggs

The pictures on this chart show the interior quality of eggs that meet the specifications of the U.S. Standards for Quality of Individual Shell Eggs with respect to albumen and yolk quality. Quality factors dealing with the shell, air cell, and defects are not included. Scores 1, 2, and 3 represent the appearance of broken-out eggs of high, average, and low AA or fresh fancy Quality; 4, 5, and 6 represent high, average, and low A Quality; 7, 8, and 9, high, average, and low B Quality; and 10, 11, and 12, high, average, and low C Quality.

candled, broken out and hard cooked appearance of the four qualities may be purchased from the same source.

Judging eggs on broken-out quality

The appearance of the broken-out egg is the critical test for quality in the eyes of the homemaker. Broken-out quality, as measured in terms of "Haugh Units", is used by many egg buyers as the basis for egg purchases.

For purposes here, Haugh values will not be used. Instead, eggs will be classified as AA, A, B, C, or inedible.

Standards are illustrated in USDA color chart, "Interior Quality of Eggs," revised April, 1960. This chart, 0-53468, may be obtained from the U.S. Government Printing Office, Washington, D.C. 20402. A black and white reproduction of this chart is shown here.

In AA-quality, the yolk is round and upstanding, the thick white is distinctly egg shaped, quite thick and quite close around the yolk and even the thin white covers a relatively small area.

In A-quality, the yolk is not quite so upstanding as in AA; the thick white still retains an outline that is oval shaped and is still relatively thick, but it does not cling so closely around the yolk as in the AA egg. The thin white does not spread over a large area.

In B-quality, the yolk can be somewhat flattened. The thick white may have lost its oval shape and is definitely thinner than in A quality but is still readily seen and its outline can be distinctly traced. The thin white spreads over a relatively large area.

In C-quality, the yolk may be decidedly flattened, but its contents must not be seeping into the white. The thick white is usually indistinguishable from the thin white spreads over a large area.

Inedible eggs would show any of the characteristics that cause shell eggs to be classified as inedible.

In addition, the yolks of broken-out eggs must meet the following standards.

AA-quality—free from defects.

A-quality—practically free from defects.

B-quality—may be slightly abnormal, or in other words, may show some slight spottiness or mottling.

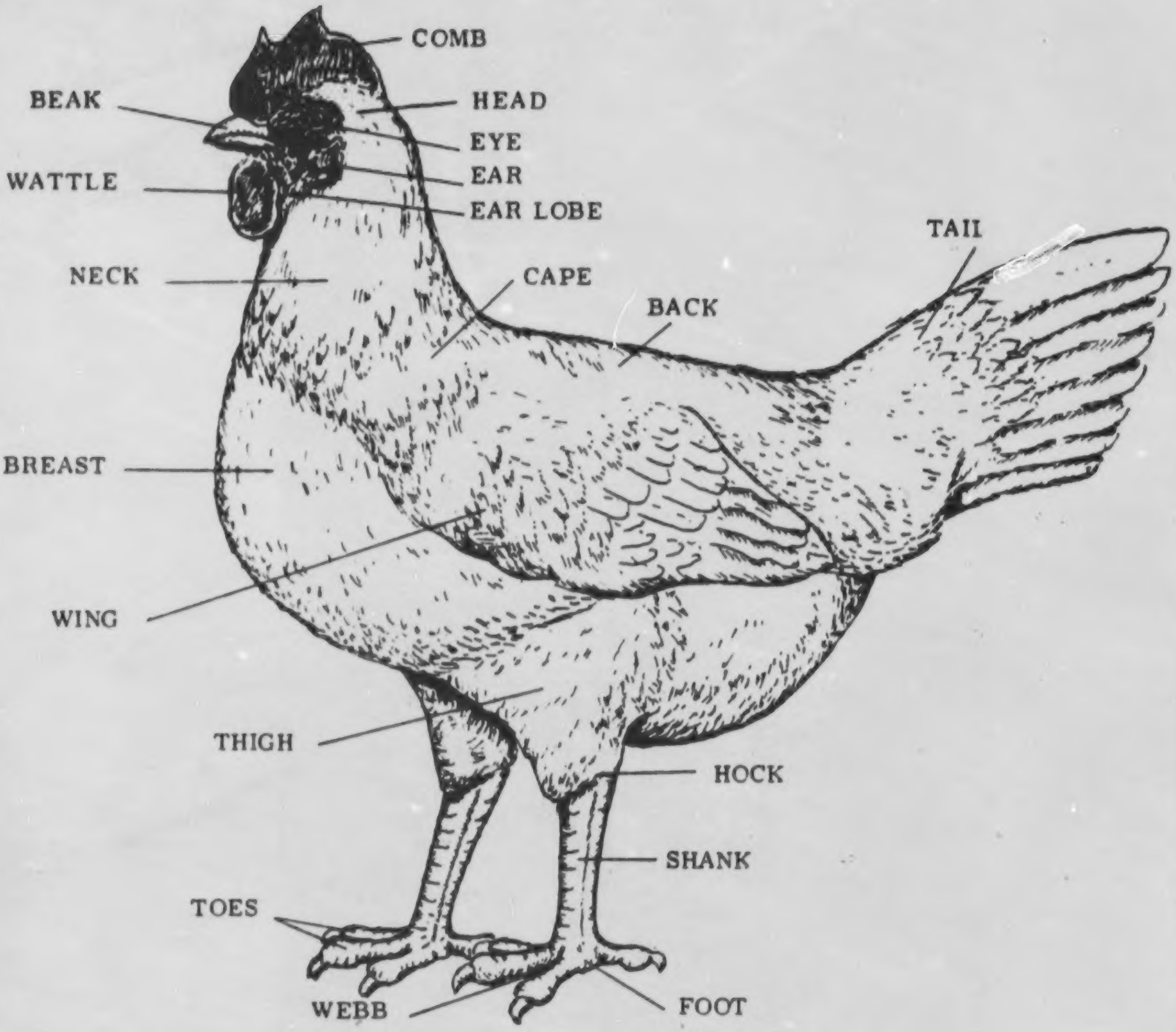
C-quality—may show clearly visible germ development but no blood; may show other serious defects. There may be some definite spots, mottling or discoloration but not to the extent that the yolk would have a repulsive appearance.

Normal variation in color of yolk is not a factor in determining the grade of a broken-out egg. Size of chalazae is not considered in determining grade.

Eggs to be judged should be broken onto a flat, hard surface large enough to permit the eggs to spread naturally. A light green background underneath the eggs makes it easier to see the edges of the whites.

The yolk surface of broken-out eggs exposed to dry air will shrivel and wrinkle in a short time. The eggs should, therefore, be judged promptly after breaking.

PARTS OF A CHICKEN


COMB
BEAK
HEAD
EYE
WATTLE
EAR
EAR LOBE
TAIL
NECK
CAPE
BACK
BREAST
WING
THIGH
HOCK
SHANK
TOES
WEBB
FOOT

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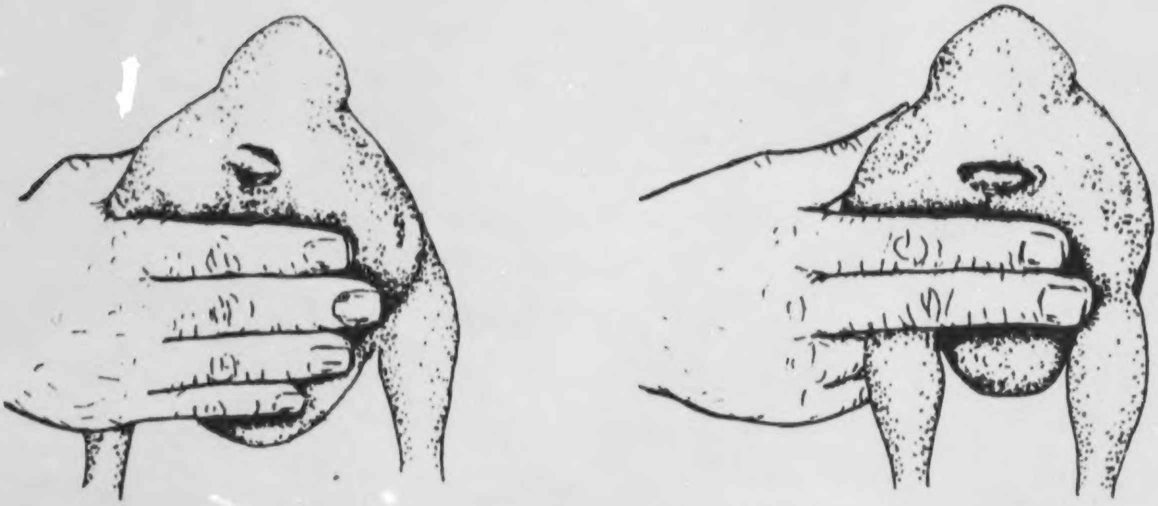
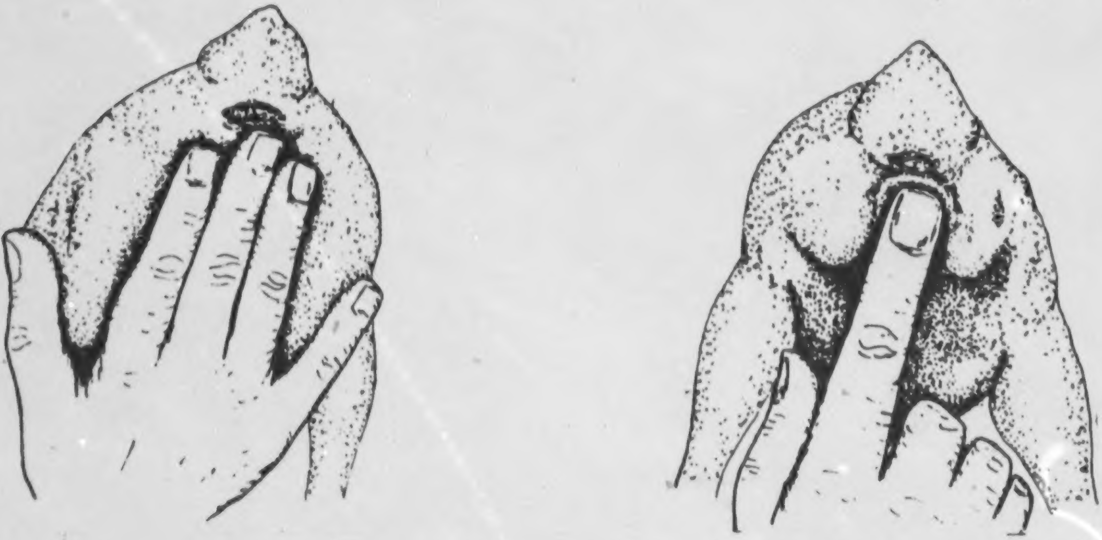
HANDLING QUALITIES OF LAYING HENS



The Distance Between the Ends of the Public Bones and the Keel Bones is Greater in the Layer (left) Than in the Non—Layer (right)



The Distance Between the Ends of the Pelvic or Public Bones in a Laying Hen (left); in a Non—Laying Hen (righ

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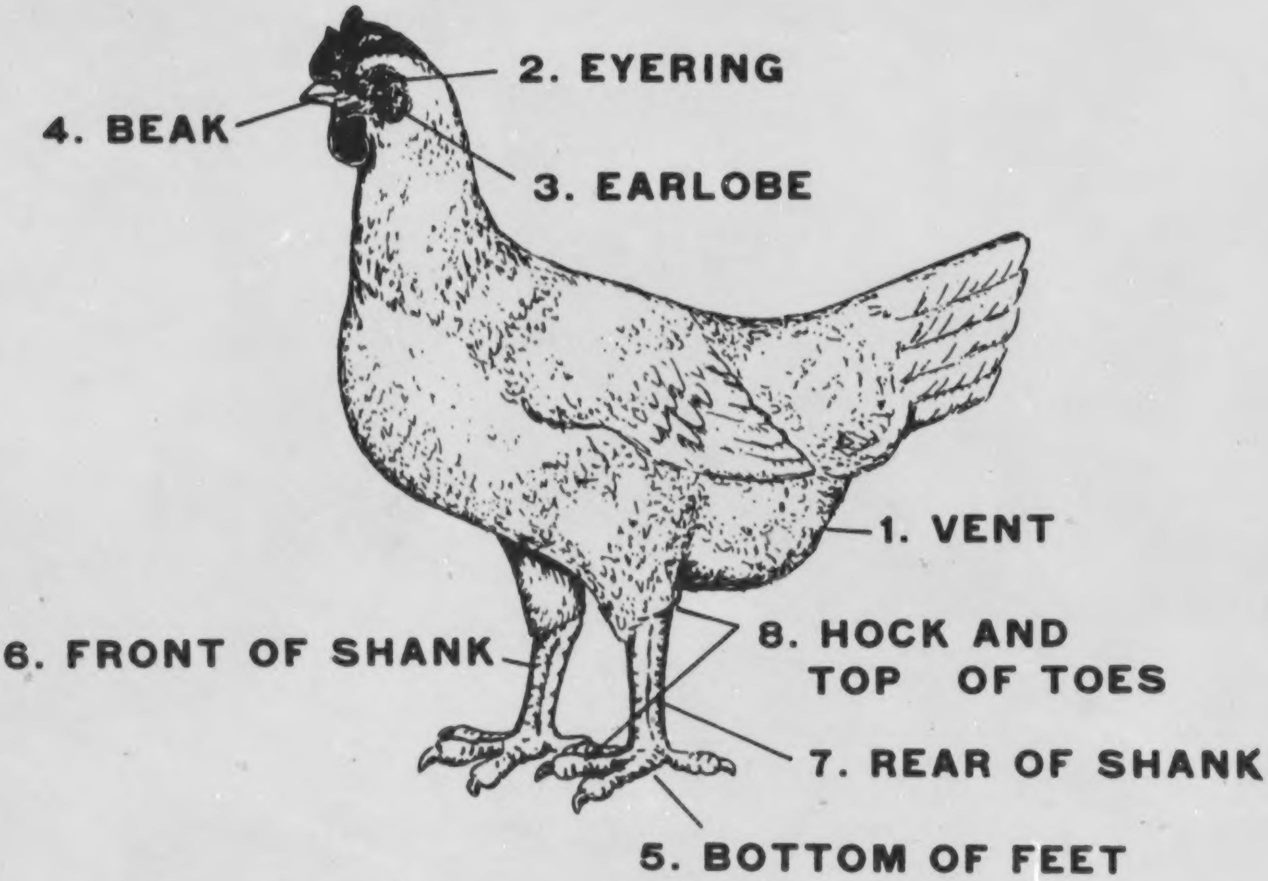
THE ORDER PIGMENT FADES


2. EYERING
4. BEAK
3. EARLOBE
1. VENT
6. FRONT OF SHANK
8. HOCK AND TOP OF TOES
7. REAR OF SHANK
5. BOTTOM OF FEET

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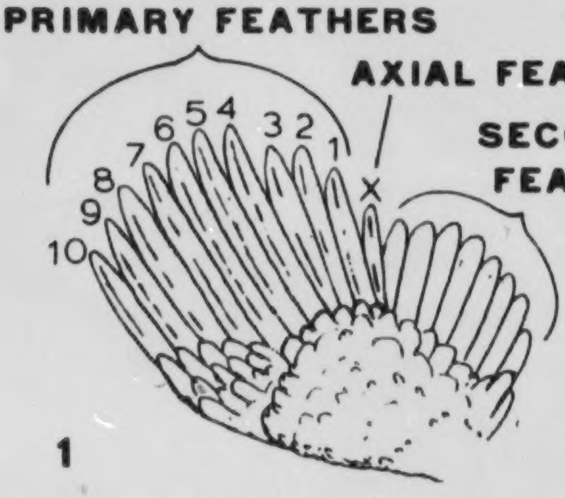
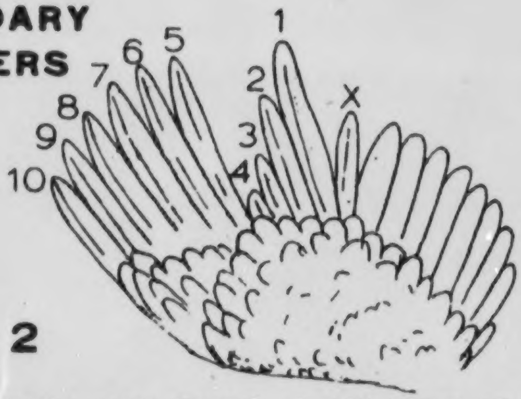
VI-96 T

WING FEATHERS IN DIFFERENT STAGES OF GROWTH


PRIMARY FEATHERS
AXIAL FEATHER
SECONDARY FEATHERS
6 5 4 3 2 1
7
8
9
10
X

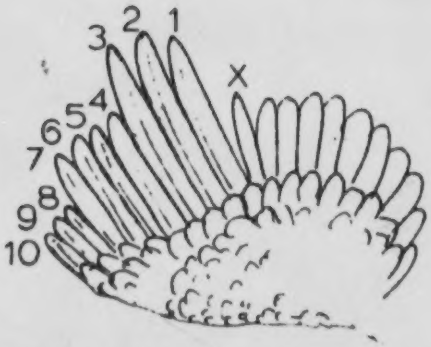
1

SHOWS THE 10 OLD PRIMARY FEATHERS. THE SECONDARY FEATHERS ARE SEPARATED BY THE AXIAL FEATHER (X)


1
7 6 5
2
X
8
3
9
4
10

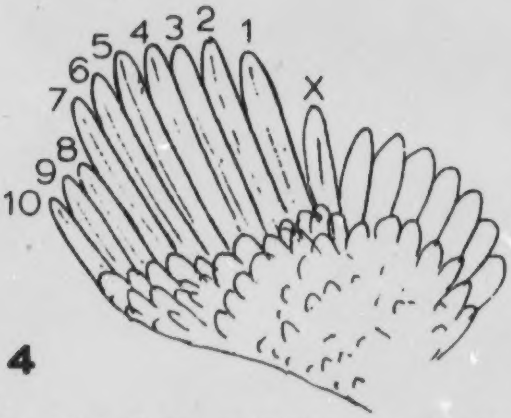
2

SHOWS A SLOW MOLTER AT SIX WEEKS OF MOLT, WITH ONE FULLY GROWN PRIMARY FEATHER AND FEATHERS 2, 3, AND 4 DEVELOPING AT TWO WEEK INTERVALS.


3 2 1
X
6 5 4
7
9 8
10

3

A FAST MOLTER HAS ALL NEW FEATHERS. FEATHERS 1 TO 3 WERE DROPPED FIRST, FEATHERS 4 TO 7 DROPPED NEXT, AND FEATHERS 8 TO 10 WERE DROPPED LAST.


5 4 3 2 1
6
X
7
9 8
10

4

TWO WEEKS LATER FEATHERS 1 TO 7 ARE FULLY GROWN. THE FAST MOLT TOOK 10 WEEKS AS COMPARED TO 24 WEEKS FOR THE SLOW MOLT.

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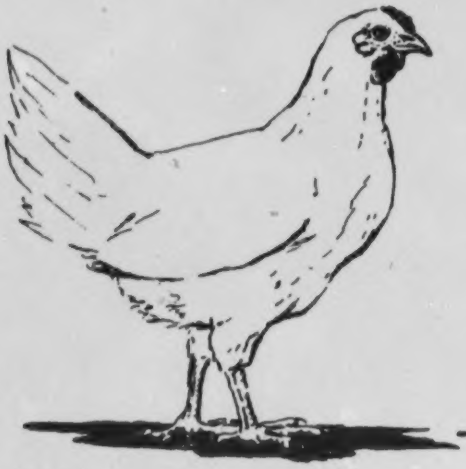
FACTORS TO CONSIDER IN SELECTING PULLETS

1. HEAD — STRONG, MODERATELY LONG, & WELL FILLED IN FORWARD TO THE EYES; THE COMB OF GOOD SIZE & SUBSTANCE & RICH IN COLOR; THE EYE SHOULD BE LARGE , BRIGHT, & PROMINENT.
2. SEXUAL MATURITY — WELL DEVELOPED COMB & HEAD; GROWTHINESS & RUGGEDNESS IN SKELETAL DEVELOPMENT AT EARLY AGE IS DESIRABLE.
3. BODY CONFORMATION — DEEP, BROAD, & WELL DEVELOPED WITH A LONG KEEL.
4. PLUMAGE CONDITION & SKIN COLOR — WITH GOOD QUALITY PLUMAGE & SHANKS SHOWING A RICH HEALTHY COLOR.
5. FEET & TOES — NORMAL DEVELOPMENT & WELL BALANCED ON LEGS.



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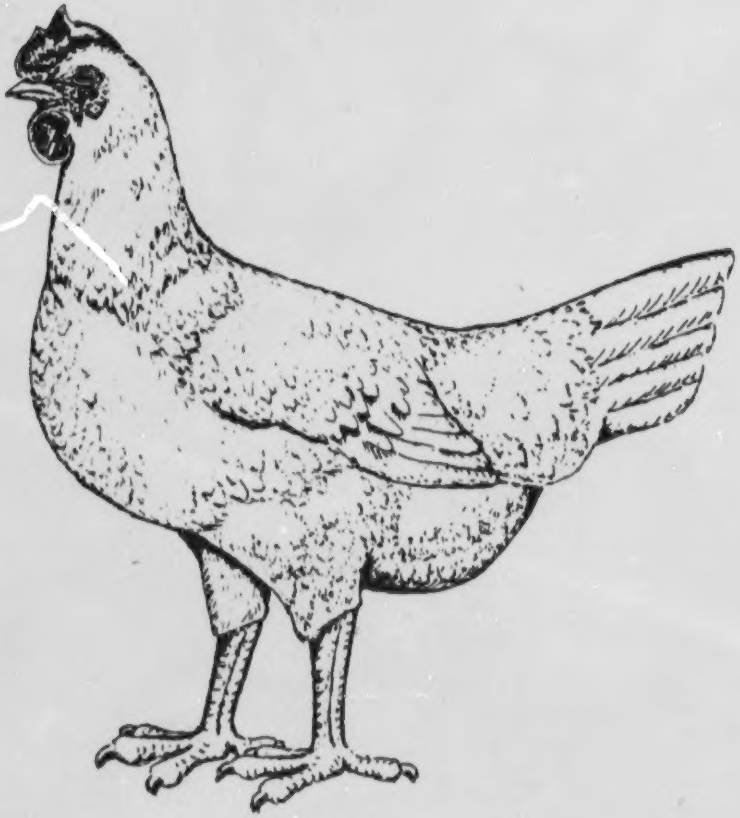
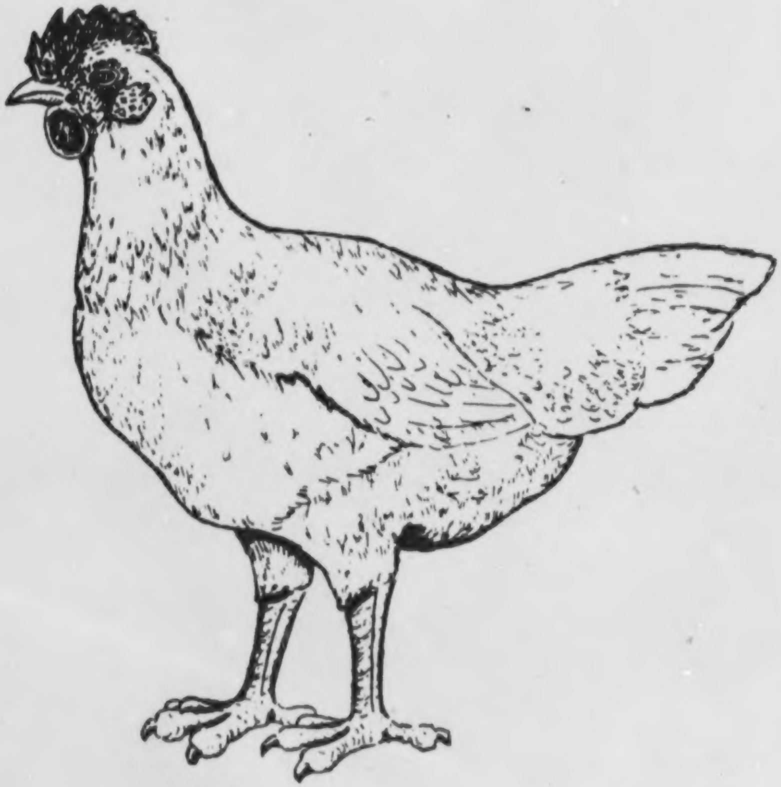
444

PULLET CONFORMATION



DESIRABLE



UNDESIRABLE

VI-98 T

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FACTORS TO CONSIDER IN SELECTING FLOCK REPLACEMENTS

❶ BACK - STRAIGHT, LONG, AND WIDE

❷ BREAST - BROAD, UNIFORM FLESHING

❸ LEGS, THIGHS, AND SHANKS - LEGS AND THIGHS WELL FLESHED; LEGS STRAIGHT

❹ FEET AND TOES - WELL FORMED, HEALTHY PADS ON FEET

❺ NECK - SMOOTH AND BLENDING WITH BODY

❻ WINGS - MUSCULAR, CLOSELY FOLDED

❼ PLUMAGE, CONDITION, AND VIGOR - WELL FEATHERED, HEALTHY, AND VIGOROUS

❽ OTHER DEFECTS - DEFORMED BEAK, BLIND EYE OR DISTORTED PUPIL, WRY OR CROOKED NECK, SPLIT WING, DEFORMED BACK, PERMANENT ABSENCE OF MAIN TAIL FEATHERS, CROOKED OR MALFORMED KEEL, CROOKED TOES (90% DEGREE ANGLE) OR DEFORMED FOOT, BREAST BLISTER ON KEEL, AND GREEN SHANKS.

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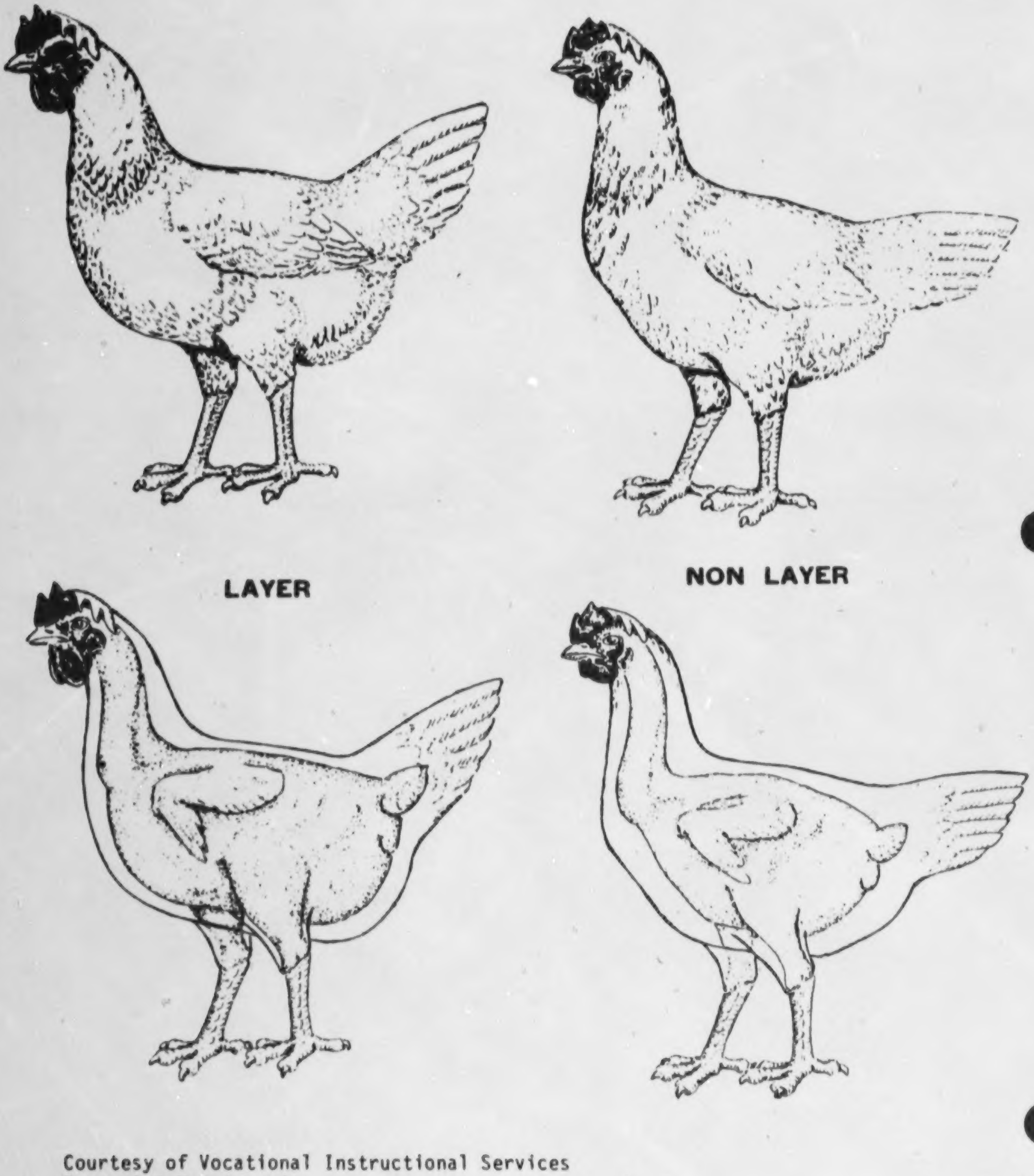
LAYER CONFORMATION


LAYER
NON LAYER

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EVALUATING HENS FOR RATE OF EGG PRODUCTION PAST AND PRESENT

1. PIGMENTATION — FADES AND RETURNS IN ORDER OF VENT, EYE RING , AND EAR LOBE (MEDITERRANEAN CLASS ONLY). ALSO BEAK, SHANKS, FEET, AND TOES.

2. HANDLING QUALITIES – WIDTH, DEPTH, AND PLIABLENESS OF ABDOMINAL SECTION; FLEXIBILITY AND SPREAD OF PELVIC BONES; AND ENLARGEMENT AND MOISTNESS OF VENT .

3. PLUMAGE CONDITION — PRESENCE OF MOLT CONDITION; ORDER OF MOLT - HEAD, NECK, BODY, WING, AND TAIL; FRAYED, WORN, OR SOILED PLUMAGE.

4. CONSTITUTIONAL VIGOR & VITALITY — FREEDOM FROM DISEASE, ACTIVE AND ALERT, STANDS ERECT AND DISPLAYS A HIGH DEGREE OF VIGOR AND VITALITY.

5. HEAD CHARACTERISTICS BROAD, DEEP, AND REFINED; COMB AND WATTLES - LARGE, PROMINENT, AND WAXY RED;EYES - BRIGHT AND ALERT

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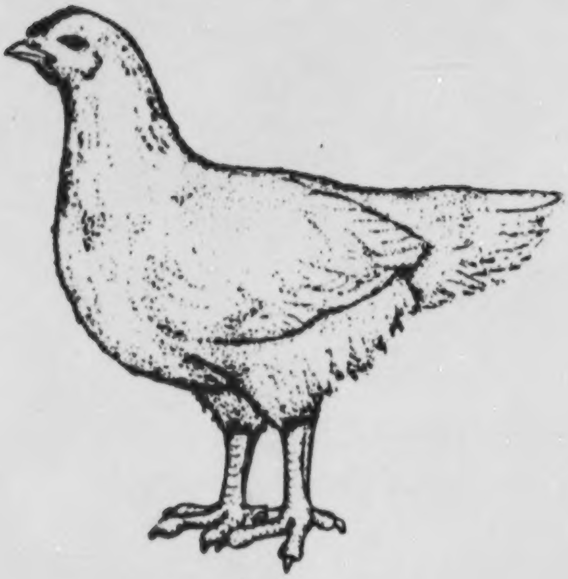
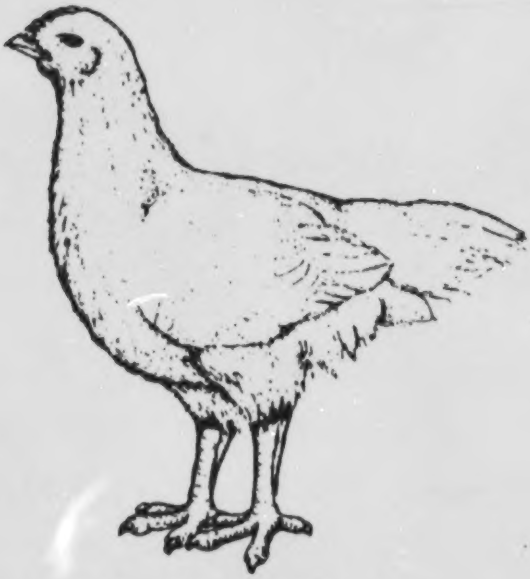
BROILER CONFORMATION

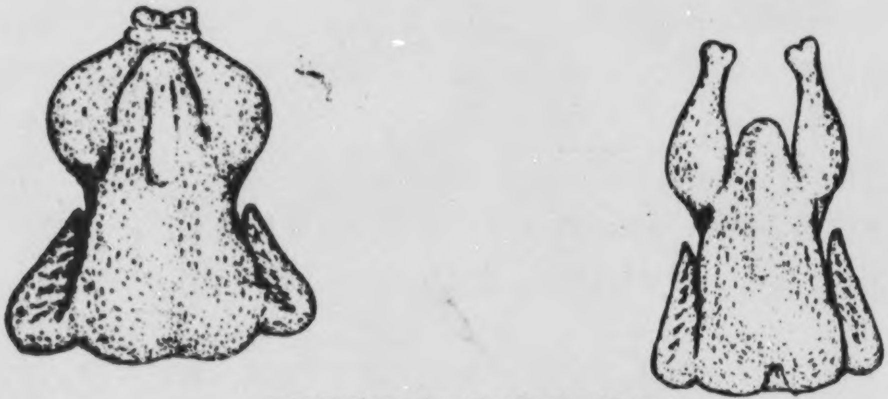
VI-102 T



DESIRABLE



UNDESIRABLE



DRESSED CARCASS

CROSS SECTION OF BREAST

450

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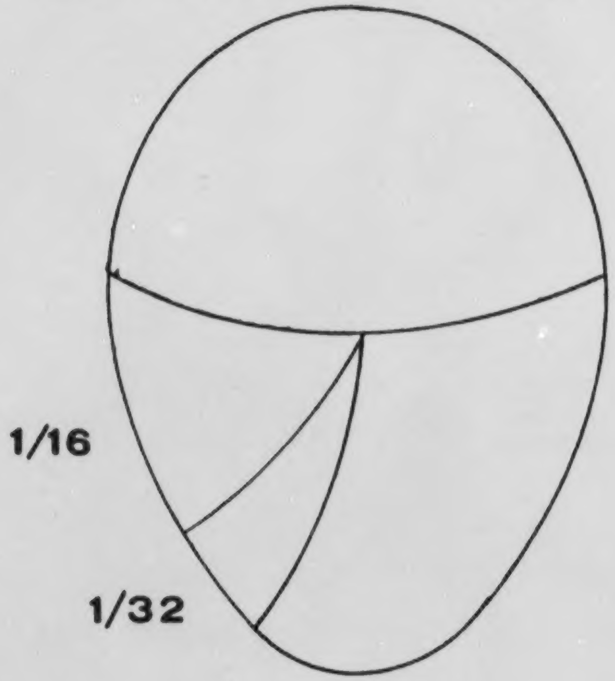
AN EGG SHOWING THE ACTUAL SIZE OF STAIN AND DIRT

1/4 of shell surface of an egg(one side)



1/32, 1/16, and 1/4 of shell surface of an egg

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LESSON 9: ANIMAL REPRODUCTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Locate and list the parts of the reproductive tract of the male and female on a diagram.
2. Write a description of the functions of parts of the reproductive system.
3. Describe the process of fertilization in the animal.
4. List the puberty and recommended breeding ages for livestock.
5. Define terms associated with the reproductive cycle.
6. Match the corresponding average gestation periods to a list of species of livestock.
7. Determine from visual observation when an animal is in "heat" or estrus and when parturition (birth) is about to occur.

MOTIVATION:

Use panty-hose, cardboard box, rubber band, and some string. Cut a verticle slot in the end of the cardboard box to represent the vulva. Attach the waist opening of the pantyhose to the slot on the inside of the box. Place a tight rubber band around the pantyhose several inches from the opening to represent the cervix. Tie off most of each leg to represent the horns of the uterus. Tie a walnut in the end of each leg to represent the ovaries. Can suspend the tract with string. Use this to begin discussion of the parts of the female reproductive tract.

REFERENCES:

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice Hall, Inc.

"Reproduction Organs of the Boar and Sow", Purdue University AS-320

Transparency Masters: "Male Reproductive System"
"Female Reproductive System"
"Fertilization in Cattle"
"Puberty Age for Farm Animals"
"Recommended Breeding Ages for Livestock"
"Reproductive Cycle of Livestock"
"Mating Guide for Beef Cattle"
"Mating Guide for Swine"

"Mating Guide for Sheep"
"Mating Guide for Horses"
"Mating Guide for Poultry"
"Methods of Mating"

OUTLINE:

A. Parts of the Reproductive Systems - see transparency

B. Functions of parts of Reproductive System:

1. Male:

    a. Scrotum - sac-like pouch suspending from body holding testicles and epididymis. Helps regulate testicle temperature.
    b. Testicle - organs that produce sperm. They also produce testosterone (hormone) causes changes in males as they mature.
    c. Sperm - sex cell produced by male.
    d. Epididymis - four functions: transport, storage, maturation, and concentration of sperm.
    e. Spermatic Cord - connects testicle with the rest of body contains blood vessels, nerve tissue, lymphatic supply, vas deferens.
    f. Vas Deferens - tube to transport sperm.
    g. Seminal Vesicles - paired glands excrete seminal fluid into urethra.
    h. Urethra - tube from bladder to end of penis transporting semen and urine.
    i. Prostate Gland - produces fluid mixed with seminal fluid.
    j. Cowpers Gland - Produces fluid that is secreted before ejaculation to neutralize and cleanse the urethra.
    k. Retractor Muscle - animals with fibro-elastic penis to return penis to sheath.
    l. Sigmoid Flexure - S-shape, allows extension of penis for copulation.
    m. Penis - external organ to deposite sperm into the female reproductive tract.
    n. Sheath - protects penis from damage.

2. Female:

    a. Vulva - external opening of reproductive and urinary tracts.
    b. Clitoris - sensory and erectile organ.
    c. Urethra - carries urine from the bladder to vagina.
    d. Vagina - connection of passageway between vulva and cervix.
    e. Cervix - acts as protective valve between uterus and vagina.
    f. Uterus - organ with two horns connected to oviducts. Fetus developes in this area.
    g. Uterine Horns - two branches that connect into one part of the uterus.
    h. Fallopian Tube (Oviducts) - two tubes that carry the eggs

from the ovaries to the uterine horns.

i. Infundibulum - receptacle for ovules (eggs) from ovaries to fallopian tubes.

j. Ovary - contains follicles for egg cell production, also secrete female sex hormones (estrogen and progesterone).

C. Process of Fertilization: Union of Sperm and Egg

1. Semen containing sperm deposited within the vagina of the female.

2. Sperm cells pass through the cervix, uterus, and into the oviducts.

3. A sperm cell will unite with an egg cell in the upper part of the oviduct if the sperm was deposited at the right time.

4. Fertilized egg moves from the oviduct to the uterus.

5. The fertilized egg (as an embryo) attaches to the uterus wall and developes being supplied with nutrients by the mother.

D. Puberty and Recommended Breeding Ages of Livestock (see transparency)

E. Reproductive Cycle Terms:

1. Estrous Cycle:

a. Includes oogenesis (the development of the ovum or egg from a primary sex cell), ovulation, and the formation of corpora lutea.

b. From the beginning of one heat period to the beginning of the next.

2. Proestrus - "Building up Phase"

a. The vaginal wall thickens and uterine vascularity increases.

b. The follicle on the ovary with its enclosed egg cell increases in size and sends estrogen into the blood stream and stimulates preparation for pregnancy.

3. Estrus - "Standing Heat"

a. Determined by circulating estrogen in the blood stream.

b. Follicle becomes large and the ovum undergoes changes.

c. Estrus ends at the time rupture of the follicle or release of the egg occurs (ovulation).

4. Metestrus:

a. Cavity left by the rupturing follicle begins to change with the remaining cells enlarging and multiplying and become laden wi fat droplets (forms the corpus luteum).

Following metestrus are different alternatives.

5. Diestrus:
    a. Short inactivity period before the next proestrus period.
    b. Occurs with animals that are polyestrous (have several estrous cycles per year).

6. Pregnancy - gestation period.

7. Pseudo Pregnancy - characteristics as if pregnant but no fetus present.

8. Anestrus - long period of inactivity between sexual seasons.
    a. A monestrous animal would follow a term of anestrus. Monestrus (one estrous cycle per year - dog).
    b. A seasonal polyestrus animal could also be in anestrus. (Seasonal polyestrus - sheep). Estrous cycles only certain seasons of a year but can have more than one cycle in each season.

F. Gestation Periods - see transparency

G. Mating Methods:

1. Hand mating:
    a. Keeping males separate from females until breeding.
    b. Female placed with male at breeding time.
    c. Allows the male to serve more females.
    d. Allows for accurate record keeping.

2. Pasture mating:
    a. Males with females throughout the season.
    b. Used on many commercial livestock.

3. Corral Mating:
    a. Used mainly by horse breeders.
    b. Placing a mare and stallion together in a well-fenced corral and returning both mare and stallion to the stall after mating.

4. Stud mating:
    a. Similar to hand mating.
    b. The male and female are allowed to breed in a pen or coop.

5. Flock mating:
    a. Similar to pasture mating.
    b. Optimum number of females for each male are placed together.

6. Pen mating:
   a. Used by poultry breeders.
   b. One male placed with a pen of hens.

7. Artificial insemination:
   a. Depositing semen in the female reproductive tract by artificial means.
   b. Used extensively on poultry, dairy, and beef animals. Can be used on horses, swine and sheep.

H. Recommended Number of Matings Per Year - see transparencies

I. Determination of Heat or Estrus:

1. Cow - cows riding on cows. Cow that is standing when mounted by bull, cow or steer.

2. Ewe - stand for ram - short estrus period.

3. Sow - contact on fenceline with boar, nervousness, and standing for mounting.

4. Mare - lifting of tail, turning of rump, urinating and standing for mounting.

J. Determination of Time of Parturition:

1. Enlargement of abdomen, mammary glands enlarge.

2. Some swelling of abdominal walls.

3. Vulva swells and usually discharges a thick mucus.

4. Relaxation of abdominal wall and sinking of flanks.

5. Dropping of belly.

6. Sinking of rump on both sides of tail head.

7. Restless behavior.

8. Seeks seclusion.

9. Lies down and gets up frequently.

10. Attempts to urinate.

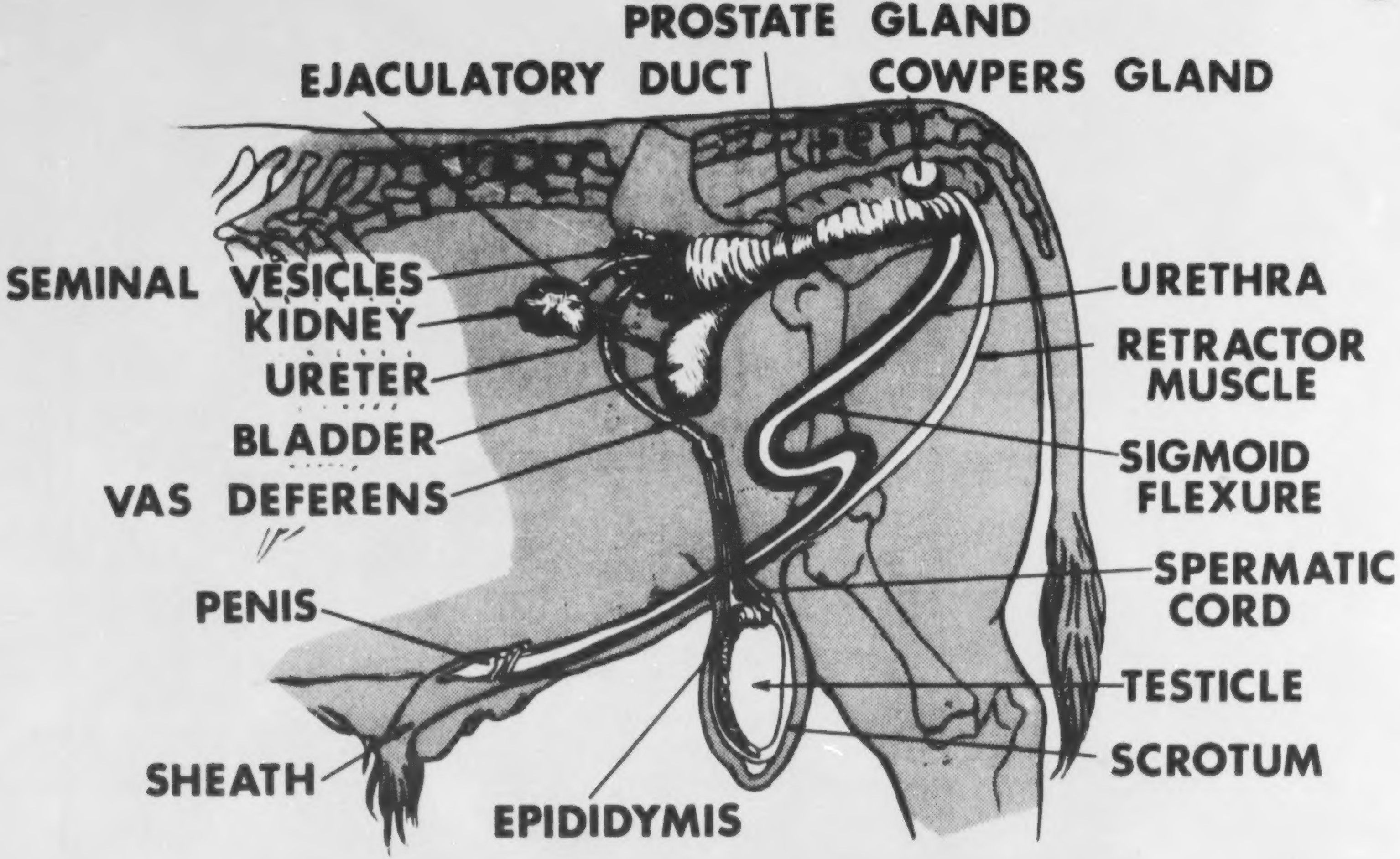
11. Sow and bitch try to build a nest.

TEACHING LEARNING ACTIVITIES:

1. Use the motivation to stimulate discussion of the parts of the reproductive systems.
2. Show the transparencies of the male and female reproductive systems and discuss the parts and their functions.
3. Lead discussion of the process of fertilization in an animal. Show the transparency to assist in discussion.
4. Set up a slide and microscope to observe sperm cells. Check on having a semen ampule from an artificial ensemination. Look for abnormalities in individual cells. Point out that sperm abnormalities can cause genetic defects.
5. Ask the class to research available references to determine puberty and recommended breeding weights and ages for each type of livestock.
6. Review or discuss the stages of the reproductive cycle.
7. Discuss methods of recognizing heat periods and pre-parturition.
8. Arrange a field trip to a livestock operation to observe animals exhibiting estrus or heat. During the same trip or on a later trip ask class to determine livestock that are close to parturition. Check with owner to see how close the class guessed.
9. Have students review references to list the number of matings per year recommended for male livestock and poultry.
10. Discuss different methods used by breeding operations in mating livestock and poultry. Refer back to what was observed during the field trip.

SUGGESTED EVALUATION:

1. Test students on class discussions.
2. Take second field trip to quiz students on determining estrus in livestock.
3. Have students write in the reproductive parts on a diagram of male and female reproductive systems.


PROSTATE GLAND
EJACULATORY DUCT
COWPERS GLAND
SEMINAL VESICLES
KIDNEY
URETER
BLADDER
VAS DEFERENS
PENIS
SHEATH
EPIDIDYMIS
URETHRA
RETRACTOR MUSCLE
SIGMOID FLEXURE
SPERMATIC CORD
TESTICLE
SCROTUM

MALE REPRODUCTIVE SYSTEM

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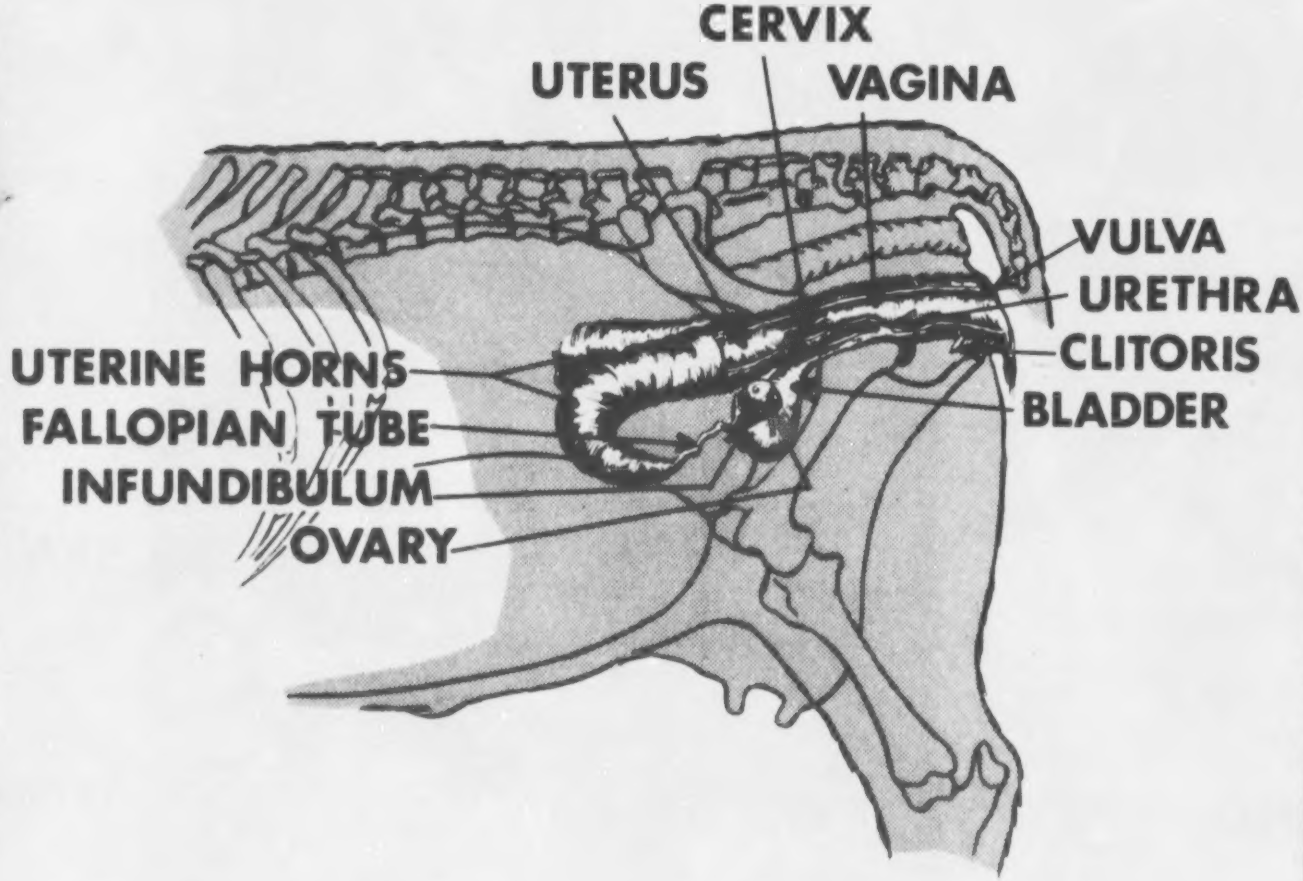
CERVIX
UTERUS
VAGINA
VULVA
URETHRA
CLITORIS
UTERINE HORNS
BLADDER
FALLOPIAN TUBE
INFUNDIBULUM
OVARY

FEMALE REPRODUCTIVE SYSTEM

460

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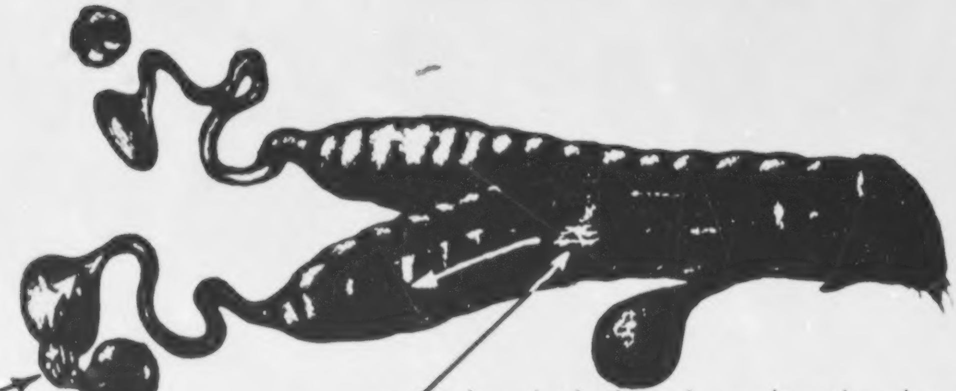
VI-112 T

FERTILIZATION IN CATTLE

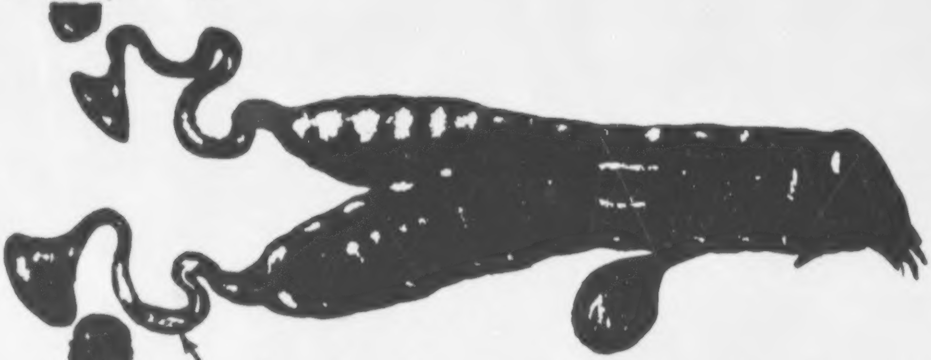
1.



egg passing through infundibulum into fallopian tube

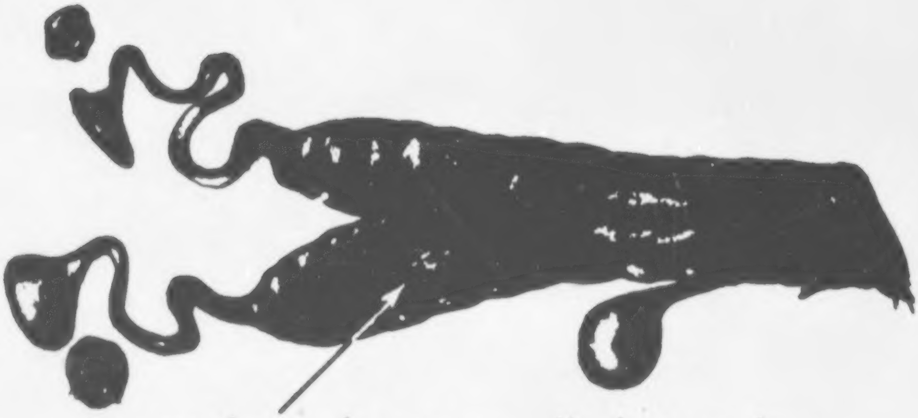
sperm deposited through cervix, migrating through uteran horn into fallopian tube

2.



union of sperm and egg and migration of zygote to uterus

3.



attachment of zygote to wall of uteran horn

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PUBERTY AGE FOR FARM ANIMALS

SPECIES	PUBERTY AGE (mo.)
SHEEP	5-8
SWINE	5-8
HORSES	12-18
CATTLE	8-14
POULTRY	5½-6½
GOATS	4-8

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RECOMMENDED BREEDING AGES FOR LIVESTOCK

SPECIES	AVERAGE AGE (mo.)	
	FEMALES	MALES
CATTLE	15-20	18-24
SWINE	8-10	8-9
SHEEP	18-19	12-20
GOATS	18-19	12-20
HORSES	24-36	24-48

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REPRODUCTIVE CYCLE OF LIVESTOCK

SPECIES	DURATION OF HEAT		DURATION OF HEAT INTERVAL (days)		TIME OF OVULATION IN RELATION TO HEAT	AVERAGE GESTATION PERIOD (days)
	RANGE	AVE.	RANGE	AVE.		
COW	8-30 hr.	14 hr.	18-24	21	14 hrs. AFTER END	281
SOW	1-5 da.	2-3 da.	18-24	21	NEAR END	113
EWE	1-3 da.	35 hr.	14-20	16	AT END	150
GOAT	2-3 da.	2½ da.	15-24	21	NEAR END	151
MARE	2-11 da.	6 da.	16-30	22	1 to 2 da. BEFORE END	336

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MATING GUIDE FOR BEEF CATTLE

MATINGS PER YEAR		
HAND MATING	PASTURE MATING	AGE OF BULL
10-12	8-10	1-2 YEARS
25-30	20-25	2-3 YEARS
40-50	25-40	3 YEARS AND OLDER

ON RANGE CONDITIONS USE 1 BULL FOR ABOUT EVERY 25 FEMALES.

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MATING GUIDE FOR SWINE

MATINGS PER YEAR		AGE OF BOAR
HAND MATING	PASTURE MATING	
24	12	8-12 MONTHS
50	35-40	1 YEAR OR OLDER

LIMIT SERVICE TO 1 PER DAY FOR YOUNG BOAR AND 2 SERVICES FOR OLDER BOAR.

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MATING GUIDE FOR SHEEP

MATINGS PER YEAR		AGE OF RAM
HAND MATING	PASTURE MATING	
20-25	NONE	LAMB
50-75	35-60	1 YEAR OR OLDER

FOR EVERY 25 TO 35 EWES, USE 1 RAM ON RANGE CONDITIONS.

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MATING GUIDE FOR HORSES

HAND MATING ONLY MATINGS/YEAR	STALLION AGE IN YEARS
10-15	2-3
20-40	3-4
30-60	4-5
80-100	5-18
20-40	over 18

Pasture mating not recommended

Courtesy of Vocational Instructional Services
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MATING GUIDE FOR POULTRY

SIZE OF BIRDS	FLOCK MATING NO. HENS/MALE	COMMENTS:
LIGHT BREEDS (Leghorns, etc.)	15-20	Males 3 years and over are not good breeders.
GENERAL PURPOSE BREEDS (White Wyandotte, etc.)	10-15	
HEAVY BREEDS (Rhode Island Red, etc.)	8-12	

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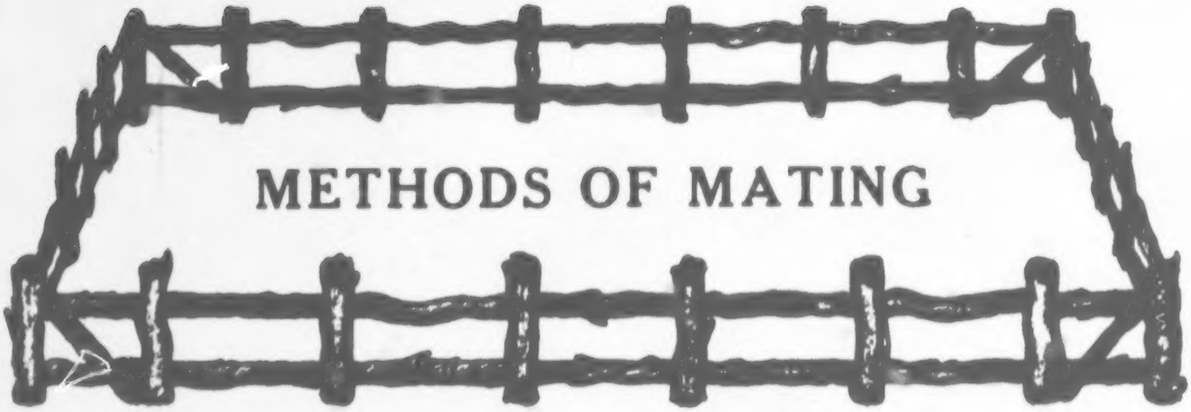

METHODS OF MATING

HAND MATING

PASTURE MATING

CORRAL MATING

STUD MATING

FLOCK MATING

PEN MATING

ARTIFICIAL INSEMINATION

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Pigs to Pork

BREEDING

Cooperative Extension Service PURDUE UNIVERSITY Lafayette, Indiana

Reproductive Organs of Boar and Sow

AS-320
Sept., 1964

Richard Hollandbeck and C. W. Foley, Animal Sciences Department

This publication is designed as a teaching aid for the intensive swine reproduction schools conducted by the Cooperative Extension Service. It is also included in the Pork Production Handbook for County Extension Agents. It is intended to offer a more thorough understanding of the swine reproductive system.

Introduction

The process by which new individuals come into being is known as reproduction. Reproduction is an orderly, systematic process by which each parent makes very definite contributions to the new individual's constitution. It is through the understanding of this process and its application to the problems of swine breeding that swine breeding is gradually becoming converted from an art to a science. When presently known principles of breeding come into more general understanding and use, further improvements in swine production and efficiency will result.

The purpose of these papers is to help you more clearly understand the present day knowledge. You can reap the harvest of greater usage of these principles and also be in a position to apply new technologies which loom over the horizon, eg. artificial insemination, controlled heat periods, sex determination and others.

Physiology of reproduction of swine is a composite science. For an appreciation of the subject it will be necessary to draw upon the accumulated knowledge of anatomy, embryology, physiology, endocrinology and genetics.

Terms and Definitions

Sperm, Spermatozoon; pl. sperm(s), Spermatozoa. The male sex cells, germ cells or gametes.

Ovum, egg; pl. ova, eggs. The female sex cells, germ cells or gametes.

Semen--The composite of sperm from the testicles and fluids from the testicles and the accessory glands.

Insemination--The deposition of semen in the female reproductive tract.

Semination--The penetration of the ovum by the sperm.

Fertilization--The penetration of the ovum by the sperm and the fusion of the male and female pronuclei.

Primordial germ cells--The earliest differentiated germ cells.

Spermatogenesis--The production of sperm.

Exocrine glands--Those whose secretions flow to the surface through a duct or tube; eg. tear glands.

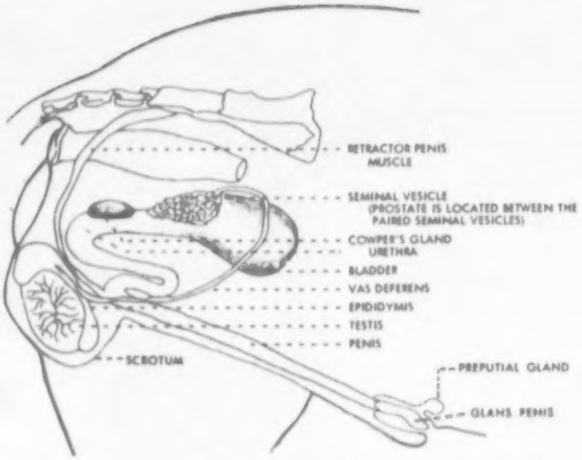


Figure 1. Diagram of the reproductive organs of the boar.

Endocrine glands--Those whose secretions pass through the cells into the blood or lymph vessels for distribution all over the body. These are the ductless glands.

The Male Genital System

The male genital system of hogs is composed of the scrotum, testicles, duct system, accessory glands, penis and sheath.

The scrotum is a sac or pouch in which the testes are suspended outside the body cavity. The function of the scrotum is twofold. It provides protection for the testicles and provides a thermal regulator. This latter function is performed by muscles which determine the nearness of the testicles to the body. The more the muscles contract the closer the testicles lie in relation to the body and the higher the temperature of the testicles. The temperature of the testicles are thus from 1 to 8^0 C cooler than the body temperature. As would be expected by the location of the scrotum of the boar, this thermal regulator function is the least developed in boars than any other farm animal.

The testicle, sometimes called testis, is a compound tubular gland with both an exocrine and an endocrine function. The exocrine function is spermatogenesis. The endocrine function is production of the male sex hormone.

The duct system is a long, twisting, curling tube about three miles long in bulls and probably slightly shorter in boars. The epididymus alone of boars is over 500 feet long. The function of the duct system is to mature, store, and provide passage of the sperm from the point of origin to the surface of the body. The epididymus provides maturing facilities.

The three accessory glands, no one of which is essential for fertility, provide the fluid portion of the semen. The three are the seminal vesicles, prostate, and cowper's glands (bulbo-urethral glands).

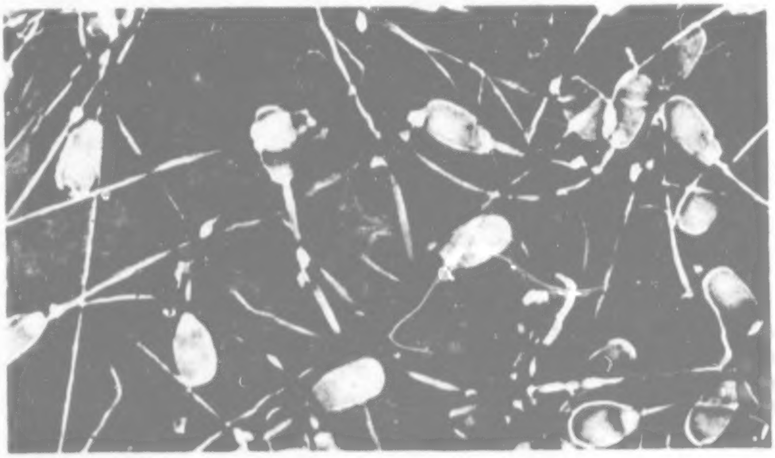


Figure 2. These boar spermatozoa are magnified about 1,000 times. About 20 billion spermatozoa are ejaculated at each service by the boar. A single sperm unites with one egg to form the new individual. Sperm are considerably smaller than the egg but each contributes equally to genetic make-up of the offspring.

The seminal vesicles are the largest of the accessories and as such are often erroneously thought to store sperm. They do not store sperm but do produce the "tapioca-like" material in boar semen. This makes up some 15 to 25% of the total semen volume of the boar and the stallion.

The prostate gland is much smaller and lies between the seminal vesicles and the cowper's glands. This prostate gland contains a rudimentary uterus which responds to estrogen, a female sex hormone, in the same way as does the uterus of the female. This estrogen response causes trouble in older men by enlarging this rudimentary uterus thus constricting the urethra. The prostate gland produces a thick fluid which imparts the characteristic odor to semen and which is also thought by many to help activate sperm motility.

The cowper's glands (bulbo-urethral) are the last of the three accessories and are intermediate in size. They secrete a clear, lubricating material (similar to thick saliva) which clears the urethra of urine prior to ejaculation and lubricates the vulva before vulvar secretions start flowing. These glands are best developed in man and in the boar.

The penis is the male organ of copulation. It deposits semen into the uterus and/or vagina of the female reproductive tract. To accomplish this it has many modifications in the various species. For example, dogs, mink, fox and raccoons have a spoon shaped bone (os penis) along the under side of the penis. The penis of the tom cat has barbs along either side. The oppossum has a forked penis, rams have a slight corkscrew prepuce and boars have a marked corkscrew prepuce. The function of the "corkscrew" is to ease the entry through the vulva and cervix because the semen is deposited into the uterus. The sheath protects the penis in the retracted state and helps guide the penis in copulation.

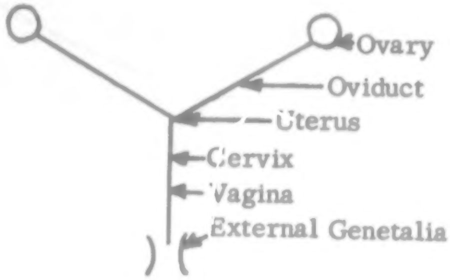
The semen is the composite of sperm and the fluids of the accessory glands. It helps activate sperm motility, provides a transport medium for sperm in the female reproductive tract and coagulates and forms a mechanical barrier to prevent loss of sperm from the female reproductive tract.

The volume and concentration of sperm varies widely from one class of farm animals to another. For example, the stallion and the boar produce sperm in low concentration in large volumes. The stallion ejaculates from 75 to 150 cc per service while the boar ejaculates 125 to 500 cc with an average of about 200 cc. Because of the large volumes ejaculated, a **boar's** mature sperm (those capable of fertilizing the ova) can be depleted due to over work. Recovery is fast, usually 24 to 48 hours. On the other hand the bull and the ram ejaculate small volumes with a higher concentration of sperm. The bull ejaculates some 1 to 14 cc per service while the ram ejaculates 1/2 to 2 cc per service.

The Female Genital System

The female genital system includes the ovaries, oviducts, uterus, cervix, vagina and external genetalia.

The following simplified diagram of the female genital system shows the location of each part in relation to the whole system.



The ovary is a dynamic organ undergoing constant changes in a rather cyclical fashion. The size, and to some extent the shape, is under complete endocrine control. This accounts for the ever changing appearance of the ovary. Many modifications of the ovary exist in various species. Each general modification reflects the usual number of young produced by the female at the time of parturition. In those species of animals having single births, the female has an oval shaped ovary. The one exception to this general statement is the mare--her ovary is kidney bean shaped. Litter bearing animals have a berry shaped ovary. This can best be visualized by thinking of the ovary as being shaped like a large dewberry or an extra large blackberry or raspberry. The rounded protrusions on the surface of the ovary are follicles, each containing one egg.

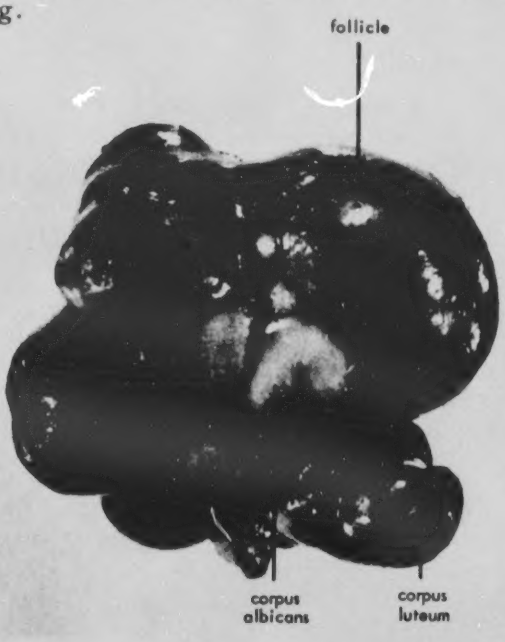


Figure 3. Ovaries of a non-pregnant gilt, magnified about 3 1/4 times. Six developing corpora lutea are on the ovaries. The large follicle on the upper ovary has not yet ruptured. When it ruptures and releases the enclosed egg to the Fallopian tube, it will become a corpus luteum like the one below it and produce hormones. If the sow does not become pregnant, the corpora lutea will regress and soon appear like the corpora albicantia (center of picture), which are left from the previous estrous cycle.

The ovarian function, like that of the testicles, is both of exocrine and endocrine. The exocrine function is oogenesis or the production of ova while the endocrine function is the production of ovarian hormones. In oogenesis, the germinal epithelium,which gives rise to the ova, covers the surface of the ovary as contrasted to its lining the seminiferous tubules in the testicle. Each cell in the germinal epithelium is, theoretically, capable of producing an ovum. In the process a single epithelium cell is slightly departed from its bordering cell and possibly becomes completely surrounded by one layer of differentiated cells to become a primary follicle containing an ovum. In the next stage of development, known as a secondary follicle, the ovum is surrounded by one or two layers of cells but with a clear ring separating the ovum and these surrounding cells. In the final stage of development, the mature follicle is very evident. This is a large, blister-like protrusion on the surface of the ovary. The ovum is now mature and capable of being fertilized upon ovulation.

Ovulation is the process by which the mature follicles are ruptured and the ova are discharged. This occurs usually near the end of the heat period. In multiple ovulation, as in sows, this takes place over a period of several hours and, as we shall see later, this accounts for the necessity of timing the mating for best results. In the process of ovulation the ruptured follicle first fills with blood and then "heals over" to form corpora lutea, commonly called yellow bodies. The corpora lutea eventually degenerate into white spots, corpora albicans, by the time of the subsequent heat period. Thus, at any one time in the ovary of a post-pubural gilt, we can see primary follicles, secondary follicles, mature follicles, yellow bodies and white spots. The ratio of one to the other varies according to the hormone influence at the stage of the cycle.

The oviduct is a very thin, tortuous tube with a funnel shaped end. There are finger-like projections found on the rim of the funnel. The oviduct picks up the discharged ova and propels them to the uterus. The propulsion is done by muscle contractions in the wall of the tube and by the wave like action of the motile cilia, hair like projections in the lumen of the tube. Fertilization usually takes place in the oviduct. In sows the eggs are in the oviduct for about 3 days.

The uterus is a hollow muscular organ which is continuous with the oviduct and opens posteriorly into the vagina. There are many types of uterii found in the various species of animals. Examples of the more prominent types are listed below.

Oppossum--2 ovaries, 2 oviducts, 2 uterii, 2 cervices, 2 vaginas, 2 external openings.

Rabbit--2 ovaries, 2 oviducts, 2 uterii, 2 cervices, 1 vagina, 1 external opening.

Sow--2 ovaries, 2 oviducts, 2 uterii, 1 cervix, 1 vagina, 1 external opening.

Cow and Ewe--2 ovaries, 2 oviducts, 2 uterine horns, 1 uterine body (partitioned), 1 cervix, 1 vagina, 1 external opening.

Mare--similar to that of cow and ewe but with no uterine partition.

Woman--similar to that of the mare but with no uterine horns and a thicker uterine body wall.

Individual females in each specie may revert back to a more primative type, but no case has ever been known to have a higher type of uterus. The last three types listed above are designed for single births. The other more primative forms are designed for multiple births. The function of the uterus is to receive the eggs from the oviducts. If the eggs are fertilized, the walls of the uterus thicken, its blood supply increases and the uterus allows the fertilized eggs to attach to the walls for the development of the new individuals. With the sow type uterus having one cervix and two uterine horns, the attachments are equalized as to number and location in each horn. The pregnant horns grow with the developing embryos and fetuses. Near term, they are much larger in diameter and longer than before fertilization.

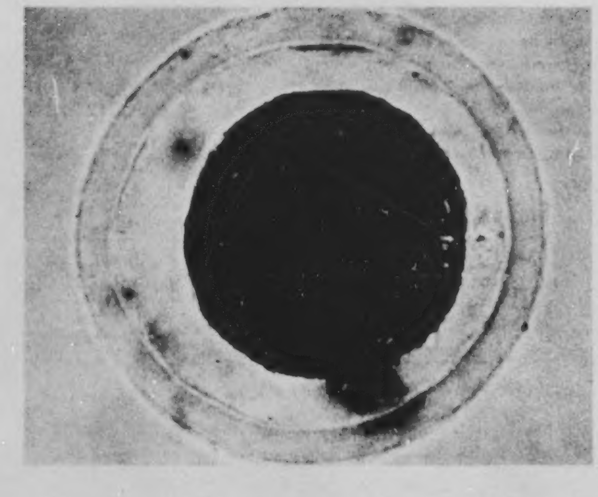


Figure 4. After the ovum or egg is fertilized it begins to divide. This picture is magnified 340 times.

The attachment of the fertilized egg to the wall of the uterus is called placentation. Ruminant animals have a cotyledenous type of placentation. In this situation there are about 100 special areas of attachment. The attachment is as the meat of an English walnut fits into its hull. The sow and the mare have a diffuse type of placentation. In this case there is a loose attachment at no particular area. The sow placentation occurs on or about the tenth to fifteenth day of pregnancy.

In all types of uterii, the blood of the mother and fetus circulate in entirely sepa-

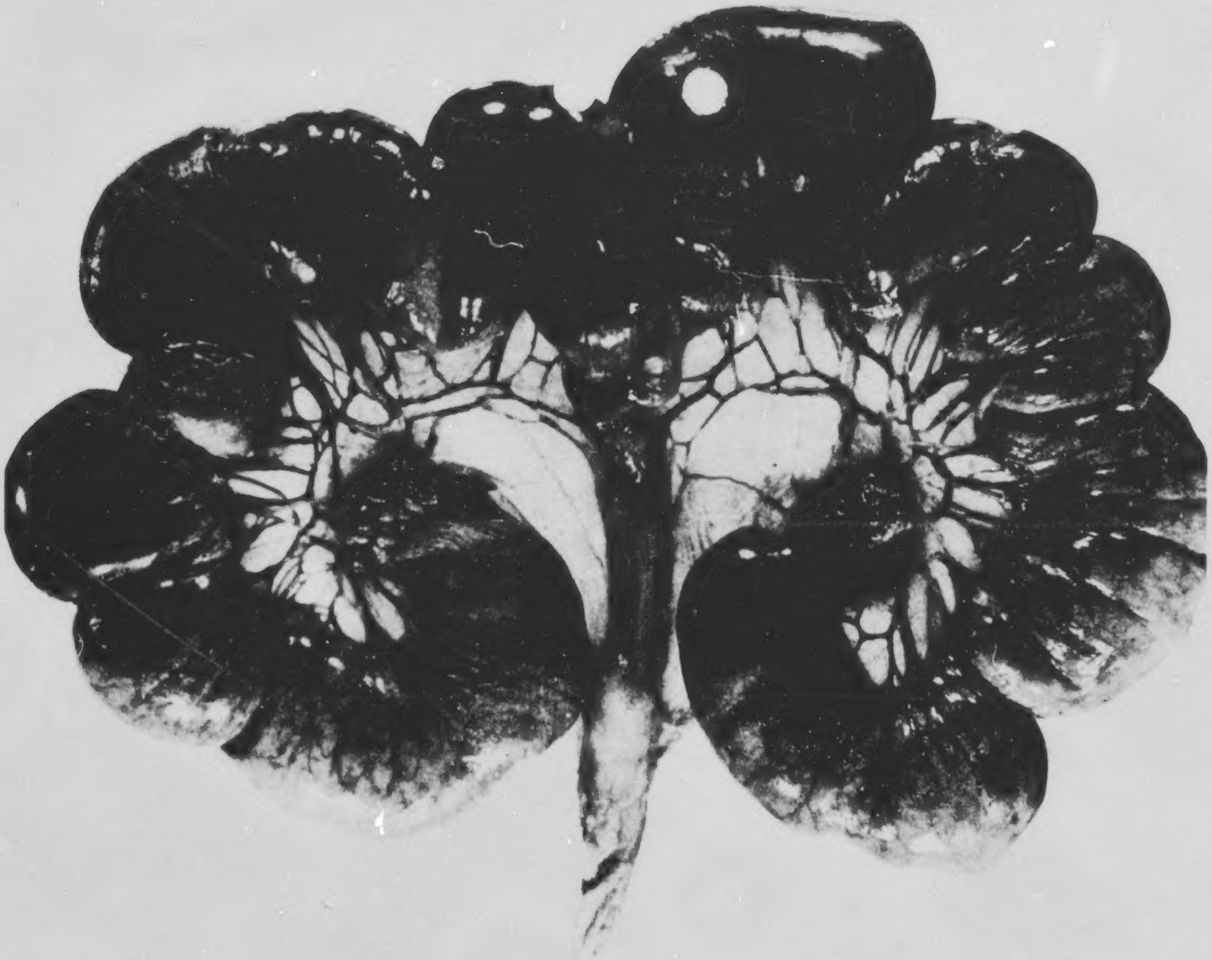
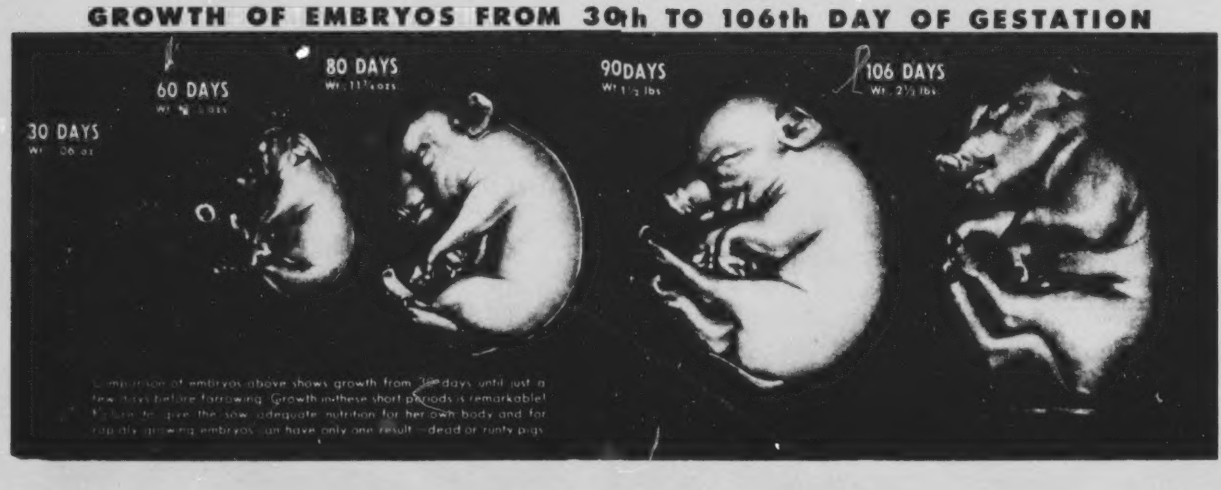


Figure 5. Reproductive tract of a gilt 28 days pregnant (approximately 1/4 actual size). Enlargement in the uterine horns and an increase in blood supply to the uterus have occurred. Embryos usually space themselves evenly, as in the nine shown here.

GROWTH OF EMBRYOS FROM 30th TO 106th DAY OF GESTATION



30 DAYS
Wt. .06 oz.
60 DAYS
Wt. [illegible] ozs.
80 DAYS
Wt. 11¾ ozs.
90DAYS
Wt 1½ lbs.
106 DAYS
Wt. 2½ lbs.

Comparison of embryos above shows growth from 30 days until just a few days before farrowing. Growth in these short periods is remarkable! Failure to give the sow adequate nutrition for her own body and for rapidly growing embryos can have only one result — dead or runty pigs.

Figure 6. One pig embryo 28 days after fertilization.

rate channels. There are no direct neural connections between the mother and the fetus. All nutrients and metabolic products must pass through both the fetal and maternal membranes of the placenta. This is commonly referred to as the placental barrier.

The cervix is the door to the uterus. It is basically a sphincter muscle. There are three basic types of cervices. These are typlified by that which appears in woman, having four interlocking annular rings, and in the mare having longitudinal folds, and lastly in the sow, having interlocking knobs. Ejaculation occurs in the uterus of the mare and the sow. The longitudinal folds of the cervix of the mare and the relaxed interlocking knobs of the cervix of the sow at the time of copulation makes for easier entry of the penis.

The cervix forms a closed door to the pregnant uterus. The cervix has glands which secrete a viscous, stringy mucous which forms a bactericidal plug over the cervix opening. If this plug is ruptured, abortion usually follows immediately. The cervix furnishes a lubricant for the vagina and vulva of the open tract.

The vagina is a tubular passage which extends horizontally through the pelvic cavity from the cervix to the external genetalia. Its function is twofold. It serves as a birth canal and it receives the semen at copulation, in all cases excepting mares and sows.

The external genetalia is made up of the clitoris and the vulva. The clitoris is the female homolog of the penis; composed of erectile tissue and containing numerous nerve endings. The vulva is the terminal part of the female genital tract.

Sterility and Impaired Fertility

The terms and definitions of sterility and fertility are:

Sterility--complete reproductive failure.

Fertility--a qualitative term of relative reproductive efficiency.

The most efficient sow, from the point of view of reproduction, is one which requires the fewest number of services per conception and shows the highest rates of ovulation, fertilization, implantation and number of pigs born. It has been found that about 10 percent of the total breeding population do not conceive.

Half of these sows were sterile because of anatomic uterine defects, tubal obstructions and cystic follicles. The other half are hard to settle sows. They show no anatomic bars to fertility and eventually conceive although a great many breedings may be required. There is no satisfactory explanation for this reluctance to conceive. These sows are sterile from the point of view of the hogman, since to rebreed them as often as is necessary to get them pregnant is neither economical nor practical.

It has been estimated that another 10 to 15 percent of the total breeding population shows some degree of impairment of **fertility.** In this category, the litter size is drastically reduced to as low as one or two pigs per litter. This is due to intrauterine fetal mortality after the implantation of a litter of normal size and cannot be blamed on infectious organisms. Nothing is known concerning the physiological causes behind this almost complete intrauterine fetal resorption.

Cooperative Extension Work in Agriculture and Home Economics
State of Indiana, Purdue University
and the United States Department of Agriculture Cooperating
H. G. Diesslin, Director, Lafayette, Indiana
Issued in furtherance of the Acts of May 8 and June 30, 1914.

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LESSON 10: ANIMAL DIGESTION

OBJECTIVES:

At the end of the lesson the student will be able to:

1. Write a definition for digestion.
2. Give a written description of how the knowledge of the digestion process is important to specific occupations.
3. Identify the parts of a simple digestive system on a diagram.
4. Identify the ruminant variations of the stomach.
5. List the functions of the parts of the monogastric and ruminant digestive systems.
6. Demonstrate the action of acid in digestion.

MOTIVATION:

Bring a carbonated beverage to class. Place a nail or other soft steel material in the beverage and have class observe the reaction. Ask the students why their digestive systems are not destroyed by this substance. Ask the class what chemicals in the beverage caused the reaction. Point out how important it is for producers to know the functions when selecting feeds. Also discuss the knowledge of digestion required for other jobs in the livestock feed, human food, and animal health industries.

REFERENCES:

Feeds and Feeding, Cullison, Reston Publishing Co.

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice-Hall, Inc.

Transparency Masters: "Digestive System of the Cow"
"Digestive System of Swine"
"Digestive System of the Chicken"

OUTLINE:

A. Digestion:

A series of processes in the digestive tract by which feeds are broken down in particle size and rendered soluble so that absorption can occur. The end result being the conversion of feed into a form that can be absorbed into the bloodstream and to the cells.

B. Importance of Knowing the Digestive System Parts and Processes:

1. Producers:
    a. To determine animal health - knowing amount of time for digestion to occur, and detect sickness.
    b. To select the correct types and rations of feed
    c. Understand why feed conversion of ruminants differ from monogastrics
    d. To determine the amount of feed and water required for animals

2. Feed Industry:
    a. Determine the nutrients required by types of livestock
    b. To figure alternate types of feed to substitute into rations with the same nutrient values and still be palatable for the animal
    c. To estimate specific rations

3. Health Industry:
    a. To detect sickness by observation of animals eating habits and waste
    b. To detect sickness by cud chewing observations, and length of time for digestion to occur
    c. Knowledge of location and function of the parts of the digestive tract to zero in on problems in a section of the tract
    d. To determine the types of medication and the quantities to administer for certain sicknesses

C. Parts of the Digestive System of Animals:

1. Mouth and pharynx

2. Esophagus

3. Stomach
    a. Hog and horse - single compartment
    b. Cow and sheep - contains rumen, reticulum, omasum and abomasum

4. Small Intestine:
    a. Duodenum
    b. Jejunum
    c. Ileum
5. Cecum or caecum
6. Large intestine
7. Anus
8. Accessory organs:
    a. Teeth - mastication of feed
    b. Tongue - taste buds and rolls feed
    c. Salivary glands - begins digestion
    d. Liver - secretes bile into small intestine to neutralize acid feed when leaving stomach
    e. Pancreas - supplies digestive juices to small intestine

D. Parts of Digestive System of Poultry:

1. Esophagus
2. Crop - storage of whole grain
3. Proventriculus - similar to one compartment stomach
4. Small intestine
    a. Duodenum
    b. Ileum
5. Gizzard - physical breakdown of feed
6. Cecum
7. Large intestine
8. Anus

E. Functions of Parts of Digestive System:

1. Mouth and pharynx - physical breakdown and some chemical breakdown of feed
2. Esophagus - food transport
3. Stomach - chemical breakdown of food and some absorption

4. Small Intestine - chemical breakdown and absorption

5. Cecum - some chemical breakdown and absorption

6. Large Intestine - chemical breakdown and absorption

F. Chain of Events of Ruminant Digestion:

1. Uses tongue to twist grass off. (cow)

2. Chews feed very little but mixes with saliva.

3. Grass moves down the esophagus to rumen.

4. Rumen contains microorganisms, bacteria, and protozoa that break down the fibrous materials.

5. The organisms (200 billion per teaspoon) die and are digested and absorbed giving nutrients to the cow.

6. Feed floating in rumen fluid is circulated about and becomes heavier sinking to the bottom.

7. A bolus (cud) is formed from the sinking material by muscular actions of the reticulum and is regurgitated for more thorough chewing.

8. The material then is reswallowed and this time because of smaller particles, goes through the reticulum to the omasum. The reticulum also acts as a trap for foreign objects like wire from entering the system.

9. The omasum removes most of the water.

10. The feed is sent to the abomasum where most of the digestion is completed. The abomasum is referred to as the true stomach.

11. The digested material is moved to the small intestine for absorption.

12. Materials not absorbed in the small intestine pass to the large intestine where water and some nutrients are absorbed and the final material excreted as feces (manure) at the anus.

G. Chain of Events of Monogastric Digestion:

1. The animal (pig) takes in food and chews and mixes well before swallowing.

2. The saliva acts to lubricate the food as in the cow and also contains enzymes that chemically break down nutrients.

3. After swallowing the food moves down the esophagus to the stomach (one compartment or simple stomach). The pig does not have a rumen for bacterial breakdown of fibers so little fiber can be digested by the pig.

4. The stomach acts as a storage compartment for injected food where most of the digestion takes place.

5. The rest of the digestion occurs in the small intestine. The small intestine is the site where most nutrients are absorbed.

6. The feed that is not absorbed or is undigested is moved from the small intestine to the cecum and the large intestine.

7. Water is absorbed in the large intestine and the remaining waste is excreted through the anus.

H. Acids in the Digestive System: (Compare to Carbonic Acid)

1. The pH in the pig's stomach is about 2.0.

2. Gastric glands secrete HCl (Hydrochloric Acid).

I. Capacities of Digestive Systems (% of Total Capacity):

	Stomach	Small Intestine	Large Intestine
1. Cow	70	19	11
2. Sheep	67	21	12
3. Horse	10	30	60
4. Pig	30	33	37
5. Dog	63	23	14

J. Digested Material Time of Movement:

	1st Appearance of Waste	Major Portion Excreted
1. Bird	2.5 hr.	24 hr.
2. Pig	14-16 hr.	65 hr.
3. Horse	16 hr.	10% in 24 hrs. 50% in 36 hrs. and 95% in 65 hrs.
4. Cow (by mouth)	12-15 hr.	70-100 hrs.
(into abomasum)	12-15 hr.	Average time = 30 hours.

TEACHING LEARNING ACTIVITIES

1. Use motivation to lead into the discussion of digestion.

2. Discuss the reasons why knowing how the digestion process occurs is important for related occupations.

3. Invite a feed company representative in to talk about the occupations of the feed industry that require knowledge of how the digestive system works.

4. Show the diagram of the parts of the monogastric digestive system. Have students look up the functions of the parts from references.

5. Show the diagram of the ruminant system and have students look up the functions of the various sections. Lead discussion on how the ruminant system compares and differs from the monogastric system. Use the outline and references to aid in discussion.

6. Have the students describe in writing the process in which digestion takes place in the monogastric system and in the rumen of a ruminent animal. Discuss the differences of the systems.

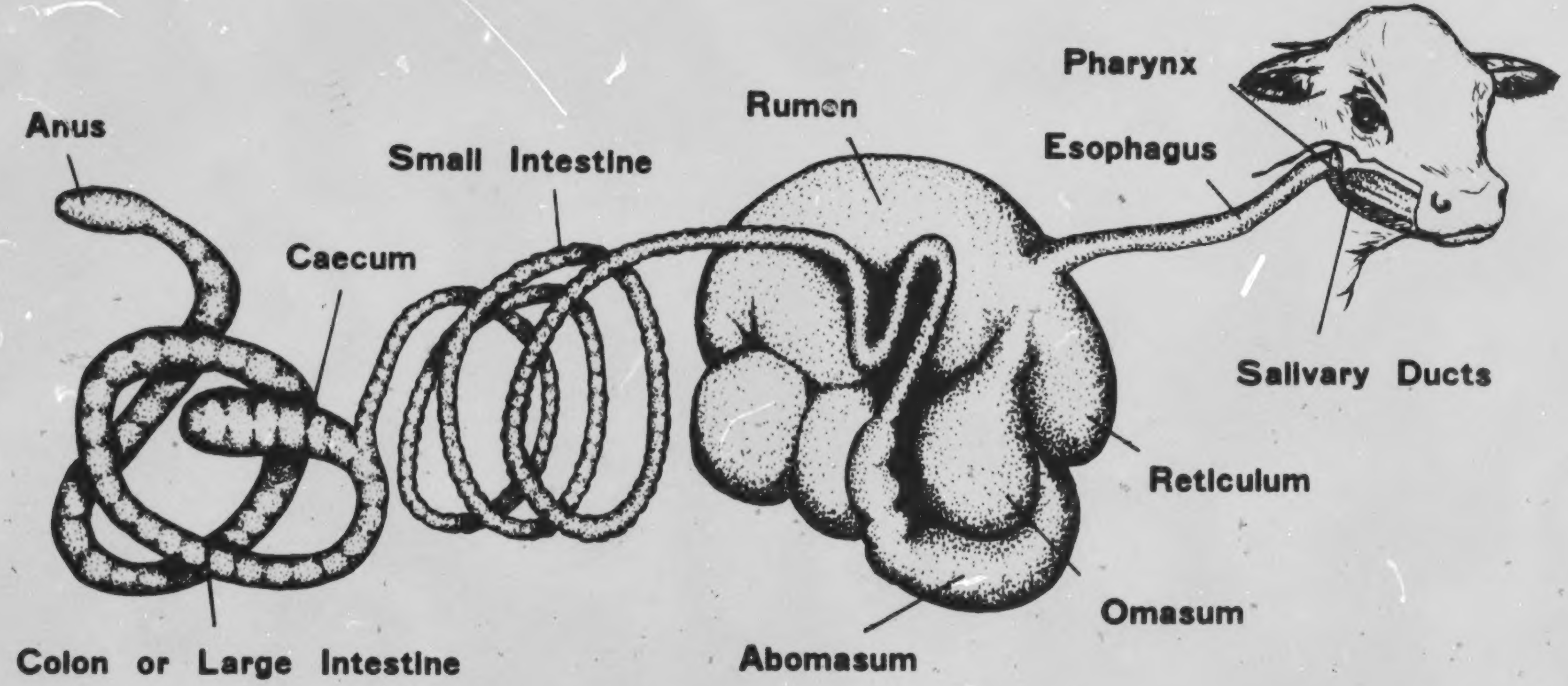
7. Ask students to guess at the percent of the total digestive system consisting of the stomach for different animals. Do the same for amount of time food is digested. Discuss with class how the differences effect the feed requirements of different animals.

SUGGESTED EVALUATION:

1. Quiz students on parts of digestive system with diagrams.

2. Give a written test based on class discussion of the lesson.

DIGESTIVE SYSTEM OF THE COW


Pharynx
Rumen
Anus
Small Intestine
Esophagus
Caecum
Salivary Ducts
Reticulum
Omasum
Colon or Large Intestine
Abomasum

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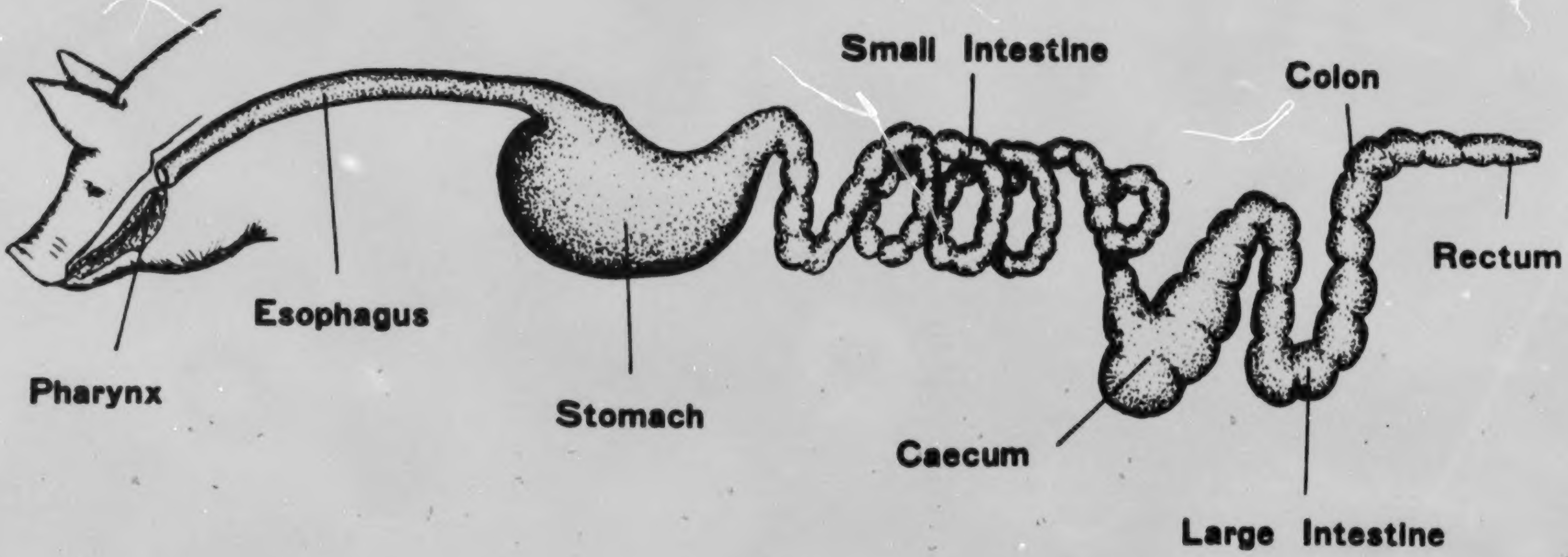
DIGESTIVE SYSTEM OF SWINE


Small Intestine
Colon
Rectum
Esophagus
Pharynx
Stomach
Caecum
Large Intestine

493

494

VI-129 T

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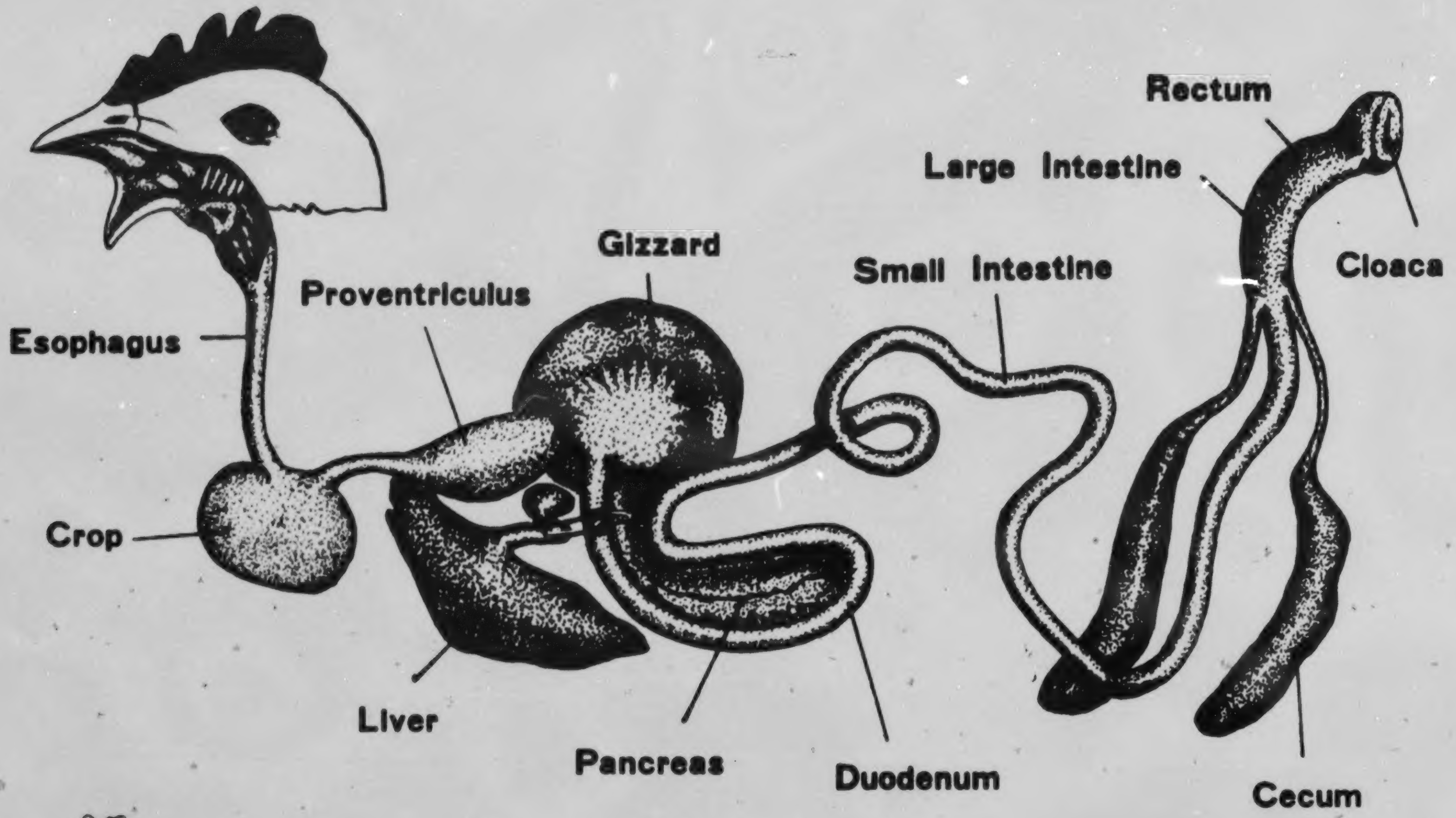
DIGESTIVE SYSTEM OF THE CHICKEN


Rectum
Large Intestine
Gizzard
Small Intestine
Cloaca
Proventriculus
Esophagus
Crop
Liver
Pancreas
Duodenum
Cecum

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LESSON 11: FEED NUTRIENTS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write a definition for nutrient.
2. List the six basic classes of nutrients that are required by animals.
3. List the functions of each nutrient.
4. Match feeds with the type of nutrient that each represents.
5. Describe in writing why there are differences in types of feed that are selected for certain animal species and feeding operations.

MOTIVATION:

Bring in a can of oil, a piece of rope, and some gravel. Inform the class that the contents of these items contain elements that would meet most of the metabolic or body functions of animals. Ask the class if these items are considered nutrients. Have the class define the term nutrient.

REFERENCES:

Feeds and Feeding, Cullison, Reston Publishing Co.

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice-Hall, Inc.

Transparency Masters: "Carbohydrates"

OUTLINE:

A. Nutrient: Any food constituent, or group of food constituents that aids in the support of animal life.

B. Six Basic Nutrients and Functions of Each:

   1. Proteins (C,H,O,N):

      a. Broken down in digestion into building blocks called Amino Acids

  b. Used for making body tissue and provide a small amount of energy

2. Carbohydrates (C.H.O):
   a. Two groups - structural and non-structural (see transparency)
   b. Used to supply energy

3. Fats and Oils or Lipids (C,H,O):
   a. 2 1/4 times more energy per pound than carbohydrates
   b. Used to supply energy

4. Minerals - 15 essential minerals:
   a. Two groups: Major (Macro) and Minor (Micro)
   b. Provide structures, activate enzymes, maintains pH in body fluids and blood

5. Vitamins-Organic compounds:
   a. Required in very small amounts
   b. Necessary for functions of the body

6. Water:
   a. Largest part of most living things
   b. Uses - transportation, removal of wastes, temperature control

C. Feeds Associated with Specific Nutrients:

1. Protein:
   a. Blood meal
   b. Tankage — Animal
   c. Fish meal
   d. Cottonseed meal
   e. Peanut kernels — Plant
   f. Soybean oil meal

2. Carbohydrates:
   a. Corn
   b. Wheat
   c. Oats
   d. Barley
   e. Rye

3. Fats and Oils:
   a. Oil seeds
   b. Animal tallow and fats

4. Minerals:

   Macro-Elements

   a. Calcium - grains and limestone (corn stover, hays)
   b. Phosphorous - Dicalcium Phosphate and grains (corn stover, hays)
   c. Potassium - forages and grasses
   d. Sodium - Sodium Chloride
   e. Chlorine - Sodium Chloride (salt)
   f. Magnesium - most feedstuffs
   g. Sulfur - most feedstuffs

   Micro- Elements

   a. Iron - combined with proteins (green leafy materials)
   b. Zinc - most feeds
   c. Copper - most feeds are adequate
   d. Cobalt - most feeds
   e. Manganese - most feeds
   f. Iodine - iodized salt, marine sources
   g. Molybdenum - no deficiency under most conditions
   h. Selenium - in very minute quantities, seldom a shortage

5. Vitamins:

   Fat Soluable

   a. A - a feed requirement
   b. D - ultraviolet light and feed sources
   c. E - feed sources
   d. K - ruminants synthesize, other animals - feed sources

   Water Soluable

   a. C - not deficient in farm animals
   b. B_1 Thiamine - feed sources
   c. B_2 Riboflavin - ruminants synthesize, other animals - feed sources
   d. Niacin - ruminant synthesize, other animals - feed sources
   e. Pyridoxine - not common to have deficiencies
   f. Pantothenic acid - cereal grains
   g. Biotin - common in feeds
   h. Folic acid - abundant in feeds
   i. B_{12} Cyanocobalamin - ruminants synthesize, other animals - feed sources
   j. Choline - common in feeds

D. Types of Feeds Required for Specific Types of Animals:

1. Cattle:

   a. Cow and calf production - high forage - rumen to utilize roughages - lower energy requirements.

   b. Feedlot cattle - higher concentrates - energy feeds for quicker gains and growth
   c. Cattle can use non-protein nitrogen to form amino acids in rumen

2. Swine - more concentrates due to simple stomach

3. Sheep - rumenant can use higher roughage ration. Use more protein nitrogen to form protein.

4. Horse - use a high forage feed, but not as efficient roughage converter as cattle.

5. Poultry - more concentrates due to simple stomach (proventriculus).

TEACHING LEARNING ACTIVITIES:

1. Use motivation to begin discussion of nutrients.

2. Ask class what are the six basic nutrients and have the class look up the functions of each.

3. List some common feedstuffs on the chalkboard and have the class identify which feedstuffs represent a specific nutrient.

4. Bring in forage and ground feed samples and have class analyze the sample for the nutrients contained. Use tag to help identify ingredients of ground feed.

5. Have students study references to determine the symptoms of animals deficient in certain vitamins and minerals.

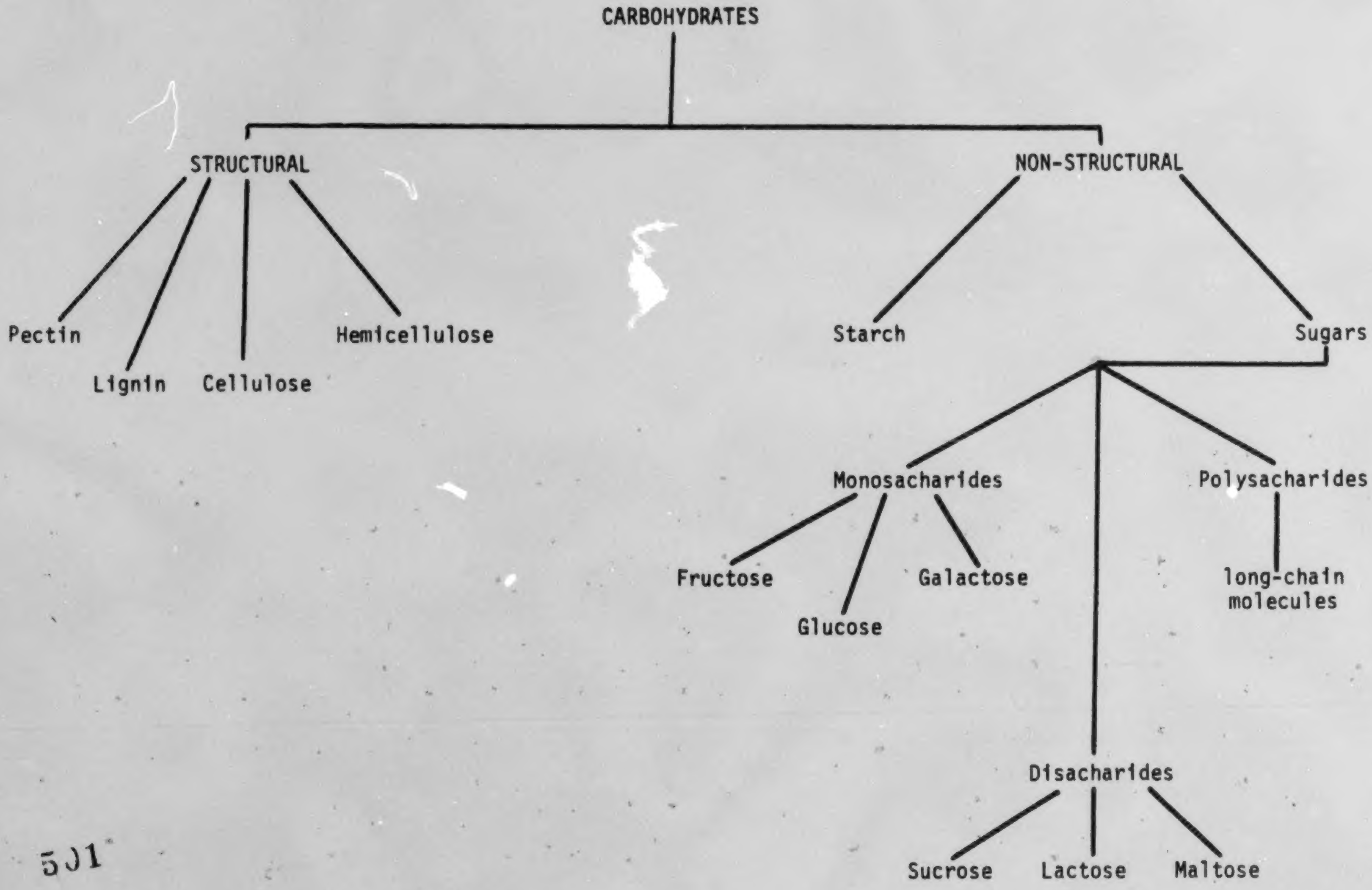
6. Ask students to list general feeds fed to different types of animals in different operations. Lead discussion as to why the animals are fed specific types of feeds for the type of animal and for maintenance or gains.

SUGGESTED EVALUATION:

1. Quiz students on materials discussed during lesson.

2. Assign grades to assignments given during the lesson.

3. Show samples of feed and have students list the nutrients that each feed supplies.



CARBOHYDRATES

STRUCTURAL

Pectin

Lignin

Cellulose

Hemicellulose

NON-STRUCTURAL

Starch

Sugars

Monosacharides

Fructose

Glucose

Galactose

Disacharides

Sucrose

Lactose

Maltose

Polysacharides

long-chain molecules

LESSON 12: FEEDING LIVESTOCK

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Define what is meant by a "balanced ration".
2. List the eight essentials of a good ration.
3. Describe the five basic types of rations.
4. Write the basic rules of thumb on feeding livestock.
5. Determine the pounds of feed required per pound of gain on a selected group of fed livestock.
6. Determine the amount of feed ingredients required in a balanced ration based on the percent of protein.
7. Make ingredient substitutions based on economic feasibility.

MOTIVATION:

Ask students what type of livestock they have. Have students explain what they feed their livestock. Ask them how much do they feed the livestock. How do you figure the ration? What is a balanced ration?

REFERENCES:

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice-Hall, Inc.

Feeds and Feeding, Cullison, Reston Publishing Co.

Transparency Masters: "Essentials of a Good Ration"
"Essential and Non-Essential Amino Acids for Swine"
"Using the Square to Figure Rations"
"Using the Square to Figure a Complete Ration"

OUTLINE:

A. Balanced Ration: The mixture of feeds that meet the animal's nutrient requirements and are fed to the animal in a twenty-four hour period.

B. Eight Essentials of a Good Ration:

1. Should be balanced - faster gains, less expense, and more profits.

2. Contains variety - increases palatability and makes balancing easier.

3. Succulent - increases production (juicy, fresh, and rich).

4. Palatable - tastey.

5. Bulky - examples: ground oats, wheat bran)

6. Laxative - makes a more efficient ration.

7. Economical - should provide the essential nutrients but should be the "best buy", not cheap quality ingredients.

8. Suitable to the digestive system of the animal.

C. Types of Rations:

1. Maintenance rations:
   a. Maintains at present weight and size
   b. High in carbohydrates and fats with small amounts of vitamins, minerals, and protein
   c. Examples of animals: non - producing breeding animals

2. Growing rations:
   a. Feeds high in protein, minerals and vitamins
   b. Includes for young animals and animals being developed for breeding stock

3. Fattening rations:
   a. Large quantities of fats and carbohydrates with ample amounts of protein
   b. Fattening animals usually confined to a feed lot

4. Producing rations:
   a. Fed a ration for maintenance and production
   b. High in protein, minerals, and vitamins with ample amounts of carbohydrates and fats
   c. Examples: dairy cattle, laying hens

5. Gestating rations:
   a. High in proteins, minerals, and vitamins
   b. Amount of feed should be regulated to control the weight and keep animal in a gaining state without becoming too fat

D. "Rules of Thumb" for Feeding Livestock:

1. Beef Cattle - eat 3% of body weight daily

    a. Two pounds air-dried roughage 100 pounds body weight. Silage substitutes three pounds for each pound of roughage
    b. Fattening cattle rations have at least 2/3 concentrate to 1/3 roughage
    c. Average gain at 2-3 lbs. per day
    d. Average feed conversion is 8:1
    e. Types of feedstuffs: energy - two kinds of grains; coarse ground or rolled; plant protein - small amount; non-protein nitrogen - urea; roughage - legume or grass source; mineral - trace mineral salt, free choice; water - 5-15 gallons per day

2. Sheep - eat 4% of body weight per day:

    a. Ewes - straight roughage of legume source
    b. Fat lambs - 1/2 concentrate - 1/2 roughage
    c. Average range of gains - .25 to .75 per day
    d. 8:1 feed conversion
    e. Feeder ration - two kinds of grain-whole, rolled or coarse ground, plant protein and roughage - legume hay, trace mineral salt free choice, and water 1-2 gallons per day

3. Swine - eat an average of 4.5% of body weight in feed each day:

    a. Bred sows and gilts - feed 12 to 15 percent roughage and regulate the amount according to weight changes of the animals
    b. Growing - fattening pigs, concentrates - grain, protein - both plant and animal sources, minerals, vitamins, and antibiotics. (Provide the 10 essential amino acids of the total 22 in the ration)
    c. Average gain - 1.5 pound per day
    d. Average feed conversion 4:1
    e. Feed materials: ground grain at least 75% of ration, plant and animal protein, roughage ground into feed mix, minerals in feed mix, water 1-3 gallons per day

4. Horse:

    a. Feed animal in small amounts frequently due to small size of stomach
    b. Feed a legume roughage first followed by grain to allow for complete digestion of fiber (helps prevent colic)
    c. Eats 1.5% of body weight per day
    d. Feed materials: whole oats, rolled or crimped grains, legume hay provides protein and roughage, trace mineral salt-free choice, water - mature horses required approximately 12 gallons per day

E. General Rules to Feeding:

1. Have clean fresh water available at all times.
2. Feed at regular times.
3. Mix feeds well.
4. Feed only as much as the animal will eat or "clean up".
5. Do not change feeds rapidly instead introduce new feeds over a period of time.
6. Provide salt and shade.
7. Provide plenty of feed trough space and keep troughs clean of old feed.

F. Pounds of Feed Per Pound of Gain - Feed Conversion:

1. Use a sample group of feedlot animals.
2. At beginning of study randomly select animals to weigh giving average weight.
3. Estimate amount of corn in storage at beginning or keep records of total amounts of feed put out in self-feeders during fattening.
4. At end find out average weights of animals.
5. Either from measurements in storage or from feed purchase or mixing records determine total amount of feed fed.
6. Take total feed fed and divide by number of livestock to get feed consumed per animal.
7. Divide the feed consumed per animal by the average weight per animal and get the feed conversion efficiency of animals.

G. Computing Rations by the Pearson's Square: (see transparencies)

TEACHING LEARNING ACTIVITIES:

1. Ask the class what makes a good ration. Discuss their answers. (Show the transparency).
2. Ask students to list the basic types of rations used to feed all livestock. Give an example of one basic ration to start discussion.

3. Divide students into groups and have each group look up information on one type of livestock's feeding requirements. Include such things as amount of feed and type, average rate of gain, feed conversions, and water required. Remind the class that their answers are averages. If greater amounts of feed can be consumed, then generally quicker gains are observed.

4. Discuss some general practices to observe in feeding animals that will improve consumption.

5. Ask a producer that has a good record system if the class can use a sample group of livestock to study in feed conversions. (see outline)

6. Explain Pearson's Square method of balancing a ration. Use the transparencies to aid in explanation. Have students figure sample rations by using the computations.

SUGGESTED EVALUATION:

1. Quiz students on discussion from lesson.

2. Have students figure feed conversions of a fictitious sample of livestock.

3. Assign students sample rations to balance.

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ESSENTIALS OF A GOOD RATION

1. **Nutrients should be balanced**

2. **Ration should contain a variety of feeds**

3. **Ration should be succulent**

4. **Ration should be palatable**

5. **Ration should be bulky**

6. **Ration should be slightly laxative**

7. **Ration should be economical**

8. **Ration should be suited to animal**

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ESSENTIAL AND NON-ESSENTIAL AMINO ACIDS FOR SWINE

Essential

- Arginine
- Histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine

Non-essential

- Alanine
- Aspartic Acid
- Citrulline
- Cystine
- Glutamic Acid
- Glycine
- Hydroxyglutamic Acid
- Hydroxyproline
- Norleucine
- Proline
- Serine
- Tyrosine

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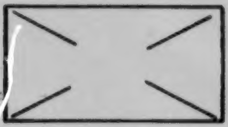
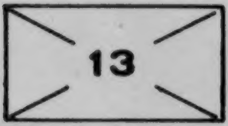
USING THE SQUARE TO FIGURE RATIONS

Step No. 1

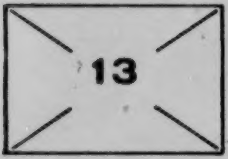


Step No. 2



Milo 8.5

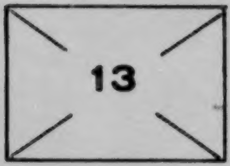
Step No. 3 and 4



C.S.M. 32.2

Milo 8.5 — 19.2 parts of Milo

Step No. 5



C.S.M. 32.2 — 4.5 parts of C.S.M

Total parts in mixture 23.7

Step No. 6 Milo 19.2÷23.7×100 = 81%

Cottonseed meal 4.5÷23.7×100 = 19%

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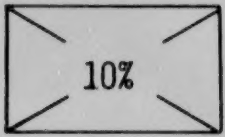
USING THE SQUARE TO FIGURE A COMPLETE RATION

STEP NO. 1

A 10 PERCENT DIGESTIBLE PROTEIN RATION IS NEEDED

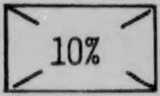
STEP NO. 2



STEP NO. 3

9 POUNDS MILO
5 POUNDS COTTONSEED HULLS

1 POUND COTTONSEED MEAL



STEP NO. 4

MILO 9 POUNDS - .765
COTTONSEED HULLS
5 POUNDS - .000
.765

COTTONSEED MEAL
1 POUND 32.2
32.2

STEP NO. 5

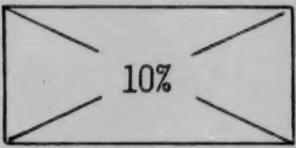
$14\overline{)\,.765}$ = 5.4 AVERAGE PROTEIN

STEP NO. 6

$1\overline{)\,32.2}$ = 32.2 AVERAGE PROTEIN

STEP NO. 7

5.4 — 22.2 PARTS OF MILO AND COTTONSEED HULLS



32.2 — 4.6 PARTS OF MEAL

26.8 POUNDS

STEP NO. 8

22.2 ÷ 26.8 X 100 = 83 PERCENT MILO AND COTTONSEED HULLS

5 ÷ 26.8 X 100 = 17 PERCENT COTTONSEED MEAL

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LESSON 13: LIVESTOCK DISEASE PREVENTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write a definition for disease.
2. List the causes of disease in livestock.
3. Identify from live animal observation the signs that indicate a healthy or unhealthy animal.
4. List average temperatures of the various classes of livestock.
5. Demonstrate taking temperature of animal.
6. Select the correct sanitation practices for a livestock enterprise.
7. Develop an animal health program for a given livestock operation.

MOTIVATION:

If you were visiting different livestock operations what would be the first clue that would tell you what kind of management it had? (Clean, orderly vs dirty, disorganized). Where is a good place to find disease problems? In a dirty environment. Develop from the discussion in the motivation that proper management is necessary for disease prevention.

REFERENCES:

Handouts:	"Health Programming in the Beef Cow Herd" Purdue University "Dairy Herd Health Programming" Purdue University "Programming for Poultry Vaccines" Purdue University
Transparency Masters:	"Average Temperatures of Livestock" "Common Sanitary Conditions"

OUTLINE:

A. Disease Definition - A change in the performance of vital functions resulting from an impairment of the normal state of an animal.

B. Classification of Diseases in Livestock

1. Infectious diseases caused by:
    - a. bacteria
    - b. viruses
    - c. parasites

2. Non infectious diseases caused by:
    - a. chemicals
    - b. poisons
    - c. faulty nutrition
    - d. injuries

C. Signs to Indicate Healthy and Unhealthy Livestock.

1. Healthy
    - a. sleek coat
    - b. normal feces and urine
    - c. normal respiration
    - d. alertness
    - e. chewing of cud (ruminants)
    - f. contentment
    - g. normal pulse rate
    - h. bright eyes and pink eye membrane
    - i. normal temperature

2. Unhealthy
    - a. rough hair coat
    - b. abnormal feces
    - c. discolored urine
    - d. fast and intermittent respiration rate
    - e. coughing
    - f. excess mucus from nose
    - g. loss of appetite
    - h. high temperature

D. Average temperatures of livestock in degrees Farenheit

1. Poultry	105-107
2. Swine	102-103.6
3. Goats	101.7-105.3
4. Sheep	100.9-103.8
5. Cattle	100.4-102.8
6. Horses	99.0-100.8

E. Common Sanitary Conditions to Establish.

1. Ventilation
2. Space for confined livestock
3. Manure disposal
4. Pasture rotation
5. Carcass disposal
6. Use of disinfectants
7. Control of rodents and birds
8. Isolation of new animals
9. Vaccination
10. Parasite control

F. Animal Health Plan Example

1. Beef Cow-Calf Plan

Calving	1. Observe herd for calving difficulty
	2. Provide extra feed for cows
	3. Dip calf's navel with iodine.
	4. Watch for scours in new born calves and treat those with scours.
	5. Dehorn calves and castrate bull calves.
Breeding	1. Evaluate Reproductive Soundness of Bulls
	2. Feed cows an increased ration
	3. Test newly-purchased breeding animals for brucellosis and leptospirosis, also test out of state purchases for tuberculosis.
Spring	1. Watch for signs of grass tetany
	2. Plan immunication of cows and replacement heifers against vibriosis, leptospirosis, IBR, and BVD
	3. Check for ringworm and warts and treat if needed
	4. Prepare back rubbers or dust bags with insecticide
Summer	1. Check for pinkeye and treat promptly
	2. Continue a fly control program
Fall	1. Vaccinate calves for IBR, BVD based on the advise of a veterinarian
	2. Worm cows and calves to be kept as replacements

2. Provide mineral mix containing magnesium oxide for grass tetany problems.

General practices

1. Vaccinate calves for black leg at 3-4 months of age
2. Check cattle for foot rot problems (lameness and swelling)
3. Trim cows feet if needed
4. Provide for manure removal and disinfecting pens before moving in new animals.
5. Keep area clear of tools or waste lumber and metal to protect animals from injury.

TEACHING LEARNING ACTIVITIES:

1. Ask the students what is disease. How can it be defined? Write out their answers and see how they compare or combine for a definition.

2. Have each student make a list of the causes of disease in livestock. Discuss how some diseases are infectious and some noninfectious. Provide examples of both classes of diseases.

3. Ask why all managers should set up their operation so that they will see all of their animals at least once a day. Ask students how they could recognize a healthy or sick animal. List their answers on the board and discuss how easy each disease symptom is to observe.

4. While discussing symptoms ask how an animal with fever can be detected. Discuss the method used in taking the temperature of an animal.

5. What temperature is normal in livestock? Have students look up the normal temperatures of different types of livestock and poultry.

6. Ask the class, "What is the best way to prevent diseases?" (Proper sanitation). What are some ways a sanitary atmosphere can be obtained? Review the outline with the class.

7. Have students develop a basic health program for a selected type of livestock. See references and outline for assistance.

8. Invite a local veterinarian to the class to give information on how to set up a health program for a specific situation. Have the veterinarian discuss methods used for applying medicine with injections, or other methods and relay information on specific disease problems that may be occurring in the community that could effect the students' livestock.

SUGGESTED EVALUATION:

1. Provide a written quiz measuring students ability to complete the objectives.

2. Provide a field trip to a veterinary clinic or other facilities for students to demonstrate taking temperature. This would also allow the students a change to observe practices and view the equipment used.

3. Assign grades to the health programs developed by the students.

VY-47
1973

Health Programming the Beef Cow Herd

K. M. Weinland, DVM, Veterinary Science and Medicine

The beef cow herd, to be economically profitable, must maintain a state of health that will enable it to produce a maximum calf crop and keep cow replacements in the herd to a minimum. The cowman knows that preventing disease and parasite infestation is cheaper than treating sick animals. In fact, it has been estimated that money invested in animal health programming will return ten-fold. Therefore, a herd health program should always be a major consideration in the beef cow enterprise, and should be planned and conducted in consultation with your veterinarian.

Health Program for the Cow Herd

High fertility and breeding efficiency are the first health considerations in the beef cow herd. The herd must produce an 85-95% calf crop to be profitable. Nine out of 10 cows of breeding age must conceive and produce a live calf once every 365 days to maintain the herd and keep it operating on the plus side. To accomplish this, the following nutrition and health factors must be considered.

HERD NUTRITION

1. Beef cows should have access to an ample supply of good quality forage as pasture and/or hay. If either quantity or quality of forage becomes inadequate during the gestation period, supplement with grain and protein.

2. A salt-mineral mixture containing calcium, phosphorus and trace minerals, particularly magnesium, should be available free-choice to the cows at all times.

3. Vitamin A, the health promoting vitamin, should be added to the mineral mixture or grain during fall and winter.

REPRODUCTION

1. Conduct a physical examination on the reproductive organs of all females of breeding age to be sure they are normal and free of infection. This is especially important in a purebred operation.

2. The bull's reproductive organs should be examined for any physical abnormalities such as small, enlarged or uneven testicles. A semen evaluation should be made at least 2 weeks prior to breeding season. Also, the bull should have good strong feet and legs with no evidence of lameness. Allow one mature bull for each 25 cows, or one yearling bull for each 15 to 20 cows.

3. The breeding period (time the bull is left with the cow herd) should not exceed 60 days. Make a record of this period. Calving will then be confined to a short period of time, making a more uniform calf crop.

4. The cows should be examined for pregnancy 45 days after the bull has been removed from the herd. Non-pregnant cows should be eliminated from the herd.

Cooperative Extension Service, PURDUE UNIVERSITY, West Lafayette, Indiana

CALVING

1. If the breeding period was recorded, one knows when to expect delivery of the calves. Normal gestation period should be 9 months plus 7 to 14 days.

2. The cows should be observed closely as they near calving time. Approaching parturition is exhibited by (a) swollen vulva, (b) a mucus string hanging from the vulva, (c) a full appearance of the udder and (d) signs of labor. If the cow is in labor for 45-60 minutes with no results (i.e., no appearance of front feet and head of calf or rear feet), she should be examined to determine whether veterinary assistance is needed. The calf should nurse the dam or be given colostral milk as soon as possible after delivery.

3. During extreme cold and wet weather, the cows should have some protection. Also, calving pens or sheds should be provided. The newborn calf can tolerate dry cold, but wet and muddy conditions are very detrimental.

PARASITE CONTROL

The cow herd should be examined at regular intervals for internal and external parasites. For internal parasites (worms), collect fecal samples from about 10% of cows and have them examined for worm egg content at a laboratory (see Purdue Extension publication VY-20, "Stomach Worms of Cattle"). For control of flies, cattle lice and cattle grubs, see Extension publications E-12, E-13 and E-14, respectively.

DISEASE CONTROL

Pre-Breeding Vaccination Program

Leptospirosis, vibriosis, bovine virus diarrhea (BVD) and infectious bovine rhinotracheitis (IBR) are infectious diseases to consider in the vaccination program prior to breeding. Any one of these contagious diseases could be a cause of abortions. In many instances, it is advisable to immunize the herd against these diseases at least 30 days before breeding. Consult a veterinarian for recommendations.

Leptospirosis is a disease caused by one or more leptospiral serotypes. It is wide spread throughout the U.S. in both domestic and wild animals and is transmissible to humans. It is one of the major causes of abortion in cattle. Other signs are a reduction in production in dairy cattle, reduced weight gains in beef cattle and death of young animals.

Vaccination as a preventive measure is practical wherever the disease is prevalent. Vaccination of all cattle of breeding age is recommended on farms where the disease has been positively diagnosed and in areas where the disease is prevalent.

Bovine vibriosis is a venereal disease of cattle quite often causing infertility and occasional abortion. The disease is caused by a bacterial organism called Vibrio fetus and is spread from animal to animal by natural breeding. Artificial insemination has reduced incidence of the disease in the dairy cattle population in the U.S., but it is quite prevalent in the beef breeds. Bovine vibriosis causes early abortion in young animals and may be the cause of temporary infertility in the beef cow herd. Positive diagnosis depends on isolation of the organism which is more readily accomplished by bacterial examination of the aborted fetus. If a cow aborts a fetus any time during gestation, an effort should be made to determine the cause.

Vaccination and annual re-vaccination are recommended in known infected herds. Vaccine should be given 30 to 120 days before breeding.

Infectious bovine rhinotracheitis (IBR) is a contagious virus disease of cattle of all ages. It exhibits respiratory signs such as a nasal discharge, coughing and an elevated temperature. The disease may also produce other clinical signs including pustular vulvovaginitis, conjunctivitis and abortion.

Effective vaccines against IBR are available. Breeding cattle should be vaccinated when they are 5 to 7 months old. If they have not received vaccine by breeding age, they should be vaccinated 3 to 4 weeks before breeding.

Bovine virus diarrhea (BVD) is a virus disease quite widespread in cattle. It causes a variety of clinical signs including diarrhea, elevated temperature, erosion of the skin of the nasal and mouth areas, dehydration, weight loss and abortion; cattle may also become lame due to laminitis.

Effective vaccines are available for BVD and quite often are given in conjunction with IBR vaccine. Non-vaccinated breeding age cattle should be vaccinated not later than 3-4 weeks before breeding.

Other Infectious Diseases

Paratuberculosis (Johne's Disease) is being diagnosed more frequently in Indiana beef cow herds. The disease, usually chronic in nature, is characterized by a severe persistant diarrhea without straining. Adult animals with this type of diarrhea and showing any evidence of unthriftiness with loss of weight, should be isolated for further diagnosis.

Trichomoniasis of cattle is a venereal disease affecting the reproductive tract in both the male and female. It may cause early abortions and difficulties in conception in the cow herd. The disease should be of concern when bulls are purchased or leased, and should be suspected in herds that have breeding problems, such as females returning to heat 45 to 60 days after breeding.

Anaplasmosis in cattle is a disease causing anemia, rise in temperature and death in many cases. The causative agent is a blood parasite transmitted from animal to animal by blood sucking insects and contaminated instruments such as needles, knives and dehorning equipment. The disease should be of concern in animals imported from the south and southwest.

Screening Tests for Brucellosis and Tuberculosis

Brucellosis and tuberculosis are two bovine diseases that come under state and federal regulatory disease control programs Market identification, slaughter examination and testing are replacing the on-the-farm testing.

Animals marketed for slaughter should be back-tagged and identified with the owner's name, address and farm of origin. When animals are slaughtered, examined for tuberculosis and tested for brucellosis, the identification numbers are recorded and traced back to the animal's original owner, who is credited with the test, whether negative or positive. These screening tests will locate infected animals and herds, thus eliminating the regular on-the-farm tests.

HERD ADDITIONS

If possible, additions to the cow herd should be raised on the farm. However, if breeding animals are purchased, they should originate from a healthy herd and be accompanied by a health certificate. The certificate should indicate (a) negative tests for brucellosis and tuberculosis, and (b) vaccinations given. A complete health history of the herd from which animals are purchased should be obtained.

Purchased bulls should be examined for evidence of physical unsoundness and semen collected and evaluated for fertility.

All purchased additions and/or animals returning from shows or sales should be separated and isolated on the farm for at least 30 days before being added to the breeding herd. This is a period for any incubating infection to become evident -- a proving time for the animals to gain entrance to the herd.

Health Program for the Calf Crop

BIRTH

1. At delivery or soon thereafter, dip the calf's navel in an antiseptic solution (7% iodine or merthiolate).

2. Identify the calf with ear tag, tattoo or other means of permanent identification.

3. Make sure the calf is nursing and that milk from the dam is available, i.e., no obstruction in the teats or extreme swelling in the udder. It is very necessary that the newborn calf receive the colostral milk from the mother as soon as possible after birth, preferably within 15 to 20 minutes.

4. Castration of males may be considered when calves are a few days old or a month or 6 weeks old.

TWO MONTHS OF AGE

1. Dehorn all calves, and castrate male calves with a knife or Burdizzo (emasculatome). Elastrators are not recommended.

2. Check identification, ear tags, tattoo or other means of identification.

THREE MONTHS OF AGE

If the producer is planning to vaccinate for brucellosis, he should do so in the third month.

FOUR MONTHS OF AGE

1. Vaccinate all calves for blackleg and malignant edema.

2. Check identification and clean up any males missed for castration and dehorning.

SIX TO 8 MONTHS OF AGE (WEANING TIME)

1. Vaccinate for infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), and leptospirosis. Vaccinations, particularly for IBR and blackleg, can be made at an earlier age then repeated at weaning time, according to the recommendations of your veterinarian. Infectious disease conditions vary considerably in different areas of the state and even on individual farms in an area. Rely on the local veterinarian for diagnosis and recommendations; it will save time, money and animals.

2. Collect fecal samples for internal parasite evaluation, and check for evidence of external parasites.

3. Check on calf identification.

4. Weigh calves and relate performance to dam.

5. Dams should be checked for pregnancy at this time.

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Feb. 1968

ANIMAL HEALTH

Dairy Herd Health Programming

Dr. K. M. Weinland, Veterinary Science and Medicine

Disease prevention

It has been said many times that an ounce of prevention is worth a pound of cure. This is true in the production of all livestock animals and animal products. The size of production units, capital invested, and the competition involved forces the producer to the utmost in efficiency. The modern dairy herd is certainly no exception. Dairy herds are selling out daily for various reasons. Some units are getting larger, but over-all cow numbers are steadily declining.

Feeding and housing practices are changing almost by the week, and construction and maintenance costs are constantly rising. The dairyman should realize that one of the essentials of an efficient operation is maintenance of good health of the herd. A definite health program is necessary.

Planned herd health:

(1) is a plan to provide dairymen with constant veterinary supervision of herds to obtain the best possible herd health.

(2) is an organized, planned program of animal health, focused upon disease prevention and cooperatively maintained by a dairyman and his veterinarian.

(3) means taking the proper action at the right time and place in a coordinated way.

(4) takes the herd approach and considers the herd as a unit.

(5) is long-term planning which requires dairyman/veterinarian confidence and complete cooperation.

It includes:

(1) examinations of the cows 30 to 60 days after calving,

(2) examinations of cows that are bred and not returning to heat 45 to 60 days after breeding,

(3) treatment of cows showing abnormalities and those failing to settle after being bred three times,

(4) mastitis control,

(5) control of calf diseases, and

(6) foot care.

How does it work?

Two basic plans of programmed herd health exist - a complete herd health plan and the more popular fertility plan. In either case, the veterinarian makes routine stops on a prearranged basis. Either plan

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covers as much or as little as a dairyman wishes to pay for, or a veterinarian wishes to perform. A program of herd health is carefully adjusted to each individual farm.

Mutual understanding is imperative! Both dairyman and veterinarian must know and accept their specific responsibilities. Neither must expect more from the other than the program provides.

Written contracts are unnecessary in most cases. A clear, solid understanding of the herd health plan and working relationship between a dairyman and veterinarian are sufficient.

It isn't the agreement which does the job! It is the plan the agreement provides. This program will prove to the dairyman that it cuts waste and returns increased profits.

General

The dairy cow starts as a calf, and the healthier start the calf has the better chance it has to grow and develop into a healthy producing cow. One of the first things to consider is that the calf is delivered with no immunity to infection. Consider the surroundings into which the calf is born. They should be as clean as possible and free of drafts. The cow's udder and flanks should be clipped and washed. The calf's navel should be clipped, if necessary, and clean disinfectant applied. The calf should receive the colostrum milk from the cow for the first three days. Excess colostrum should be saved for future auxiliary calf feedings. The colostrum milk contains immune antibodies, carotene to form vitamin A and an increased amount of protein (3 times as much as other milk). It gives the newborn calf the best kind of protection against infection that is immediately available. The calf should receive colostrum as soon as possible after birth and if it is unable to nurse, milk should be milked from the cow and fed to the calf. The calf should remain on the dam's milk for a minimum of 3 days.

The next step in developing a disease prevention program is to vaccinate the calf for brucellosis at 3 to 7 months of age. Horns and extra teats can be removed at the same time. In some areas it might be necessary to vaccinate for blackleg and leptospirosis at 6 months or earlier. With proper management and nutrition, the heifer should grow to breeding age.

Several factors should be considered when it is necessary to buy replacements for the dairy herd. If replacements are bought routinely, a permanent source of animals should be secured. The management practices and herd health management of the operation should be well known to the purchaser. It is usually wise to buy heifers, either open or bred, with a written health record which would include vaccination records, age, records of heat periods, and so forth.

Fertility program

There are four important steps in the fertility herd health program:

(1) It is good practice to have the reproductive organs checked on the heifer at least 30 days before breeding. This might reveal abnormalities such as a freemartin heifer, a malformed uterus or ovaries. Cows that had calved 30 to 60 days previously could also be examined on this trip.

(2) All females should again be examined for pregnancy 45 to 60 days following breeding if they have stopped cycling. Heat dates and breeding dates should be recorded.

(3) Special examinations should be given to cows that:

(a) have unusual heat intervals, less than 15 days or more than 28 days,

(b) do not return to heat,

(c) have an abnormal discharge from the reproductive tract,

(d) have had 3 or more services.

(4) This is the most important step in the whole program - a complete record on all animals, including heat dates, breeding dates, calving dates, vaccination records, and so forth.

The control of mastitis and other diseases depends on basic principles of disease prevention. They should include the following:

(a) maintenance of a high level of nutrition in the herd,

(b) provision of adequate well-ventilated housing with plenty of sunshine and bedding,

(c) maintenance of strict sanitation,

(d) control of rodents, flies, birds, and other vectors of disease,

(e) keeping a closed herd with minimal additions,

(f) isolation of sick animals when disease strikes and isolation of all new animals,

(g) obtaining a prompt, accurate diagnosis and treatment.

Get to know the veterinarian in your area. Find one in whom you have confidence and with whom you can discuss herd health problems, and the cost and savings involved. Most veterinarians realize that producers must profit in order for the practice to profit.

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ANIMAL HEALTH

Programming of Poultry Vaccines

R. W. Winterfield, D. V. M.

INTRODUCTION

Are your vaccines giving you maximum flock protection? Are you obtaining the maximum benefits from your vaccination program? The selection of vaccines and the program for their use should be based on serious, intelligent consideration if flock problems are to be minimized when a severe field challenge occurs. Some of these considerations are presented here.

HOW SHOULD YOU SELECT A VACCINE?

Most importantly, vaccines should be purchased from a reputable manufacturer, who produces his vaccines under a sound quality control program. The control program should, of course, be combined with an extensive research program. Particular attention should be given to such live virus vaccines as Newcastle disease, infectious bronchitis, pox and laryngotracheitis. These vaccines can introduce infectious agents (mycoplasma, coliform, salmonella and others) into a flock unless the manufacturer exercises vigilance over his manufacturing and control procedures to prevent contamination. While the federal government has certain minimum standards which serve as guidelines, one should still rely on the integrity of a manufacturer. The latter should have a long history of producing relatively trouble-free vaccines.

Reliance must also be placed on the judgment of the manufacturer regarding the selection of viruses or agents he uses in his vaccines. For example, no vaccine strain should be used which creates undue stress, or which provokes unnecessary reactions in a flock.

Unfortunately, complications occur occasionally in the field over which the manufacturer has little or no control. These variables, pathogenic coliform infection, mycoplasma, faulty brooder house management, to name a few, may be present when a vaccine virus is given, and may cause problems. Therefore, the manufacturer must seek a middle-of-the-road approach: a mild reaction that is compatible with a good serviceable immunity for the diverse field circumstances which exist over the entire country, in different areas and on individual farms.

IS THERE A ONE BEST VACCINATION PROGRAM FOR YOUR FLOCKS?

After an appropriate high-quality vaccine has been selected, it must be systematically programmed into an area, operation or individual flock. This is extremely important, since failure may result with even the best vaccine if it is not applied in a program tailored specifically to individual needs. A competent poultry pathologist who is backed up by a well-equipped laboratory can be of considerable assistance with this task. Call him for this help.

In addition, the progressive vaccine manufacturer should have technical service support for his product usage. The

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manufacturer and distributor of a vaccine must provide not only the vaccine, but also the necessary service to obtain the most satisfactory performance from his product in your flocks. Let him assist you, too.

WHEN SHOULD YOU COMMENCE VACCINATING?

While this depends on individual flock conditions, initial vaccination of chickens against Newcastle disease and infectious bronchitis should generally be done between 8 and 12 days of age. The timing of initial or early vaccination is important - especially with broilers. The reaction in the post-vaccination period and the subsequent immunity response is affected by (1) the quality of the chicks, (2) parental immunity present, and (3) brooding conditions. Therefore, in some operations it is desirable to vaccinate as early as seven days of age, whereas in others, vaccination may be delayed until 12-14 days to achieve optimum results.

The B1-strain of Newcastle disease virus is recommended at the first vaccination. It is milder than most of the other strains that are designated as B1-type and which should be used primarily for re-vaccination purposes. The B1-strain is, therefore, suited ideally for the first vaccination of light-breed chickens and broilers where concurrent infections from mycoplasma and/or coliform organisms are apt to occur. It is also more suited to those chicks whose parental immunity status is in doubt or in cases where this immunity may be at a low level.

HOW SHOULD YOU VACCINATE?

The drinking water method of administering Newcastle and bronchitis vaccine is recommended, unless the chickens are to be handled for some other purpose, such as debeaking. Here the eye or nose drop method can be substituted. It is very important, however, that the vaccine possess a high virus concentration (titer); and, if the water route is employed, that it be administered exactly as prescribed. Remember that any mass-vaccination method has more variables when compared to individual administration.

Infectious bronchitis vaccine is most often administered in combination with the Newcastle disease vaccine. It should be of a mild nature and should also contain the so-called Massachusetts-type virus if a broad, more durable protection is to be achieved. A vaccine containing only the Connecticut-type virus is not generally recommended because of its somewhat limited immunizing capacity. If a very mild reaction is preferred, the Connecticut-type virus may be used. Its protective limitations, as compared to a highly immunogenic Massachusetts-type vaccine virus should be recognized, however.

In the case of light-breed chickens, it is advisable to revaccinate within three to five weeks after the first vaccination. A B1-type Newcastle disease vaccine strain, in combination with a mild infectious bronchitis vaccine is recommended. For the most part, broilers should not be revaccinated, but this is again dependent upon area circumstances and the virus challenge present. The final Newcastle-bronchitis vaccination of pullets should be done between 16 and 18 weeks of age, since a long-lasting broad spectrum immunity is the goal. Vaccine viruses, Newcastle and bronchitis, given at this time can be stronger in nature, or of greater reactivity, than the vaccines used earlier. The necessary depth and breadth of immunity for the laying year will more likely be achieved if this is done. Since variant bronchitis virus types may be in the field, adequate protection is a necessity to prevent problems in the laying house.

Further revaccination is not generally necessary until five to six months later. At this time, the flock can be revaccinated against Newcastle disease to boost the protection. Bronchitis revaccination is not often essential at this late date; and little will be gained from further exposure to the vaccine virus providing, of course, that a good vaccine was employed just prior to reproductive maturity.

EPIDEMIC TREMOR (AVIAN ENCEPHALOMYELITIS)?

To prevent drops in egg production from this disease, and virus transmission to chicks from the parent stock, all pullets should be vaccinated at 14-16 weeks of age. Since the immunity response to the vaccine is often variable, some pullet-growing operations vaccinate their flocks twice: at four to five weeks and again at 14-16 weeks. This is a good practice to follow -- especially with pullets destined for breeding purposes. After breeders reach reproductive maturity, the pullets should be tested for the level of immunity. This can be done by submitting eggs to a laboratory that is capable of running the test.

DO WE NEED TO VACCINATE AGAINST POX?

Definitely! An improved pigeon-pox type of vaccine is recommended for pullets and should be administered after ten weeks of age if only one vaccination is to be given.

A pigeon-pox vaccine, possessing a high titer and good immunizing characteristics, will provide less stress on the birds than a conventional, more virulent fowl-pox vaccine. Fewer complications will result from blackhead, coccidiosis, and other conditions, and yet the pox protection should be satisfactory.

However, it must be pointed out that at least one manufacturer does produce a mild fowl pox vaccine which has proven highly successful for immunizing birds while imposing little stress on the flock. Note: fowl-pox vaccine should definitely be used on turkeys and applied by the thigh-stab or feather follicle (spray) method.

INFECTIOUS LARYNGOTRACHEITIS

This disease is easier to prevent than most virus-caused respiratory diseases through isolation and control of human traffic and movement of chickens. Vaccination is not recommended except in areas or on farms where the disease is prevalent. If vaccination is done, it should be accomplished at four weeks of age. Revaccination of pullets should take place at 12-16 weeks, since one vaccination will not stimulate long-lasting immunity. In each case, a mild or modified live vaccine virus is recommended. The virulent, vent brush-type only serves to perpetuate the disease and is not recommended.

IS FOWL CHOLERA A THREAT TO YOUR CHICKEN AND TURKEY FLOCKS?

If it is, vaccination may be in order. However, present day fowl cholera bacterins do not give as complete protection as is often desirable. Breaks may occur and treatment is then unnecessary. In spite of this, vaccination will reduce losses, as comparisons made between vaccinated and non-vaccinated birds during a field exposure have shown.

Generally, an emulsified, oil-type bacterin stimulates better protection than an aqueous or water-based bacterin, but it sometimes causes an adverse reaction and a swelling (or necrosis) in the neck tissues. Therefore, it should never be used on hens (chickens or turkeys) that are in production or near the beginning of production.

Two or three vaccinations, spaced 3-4 weeks apart, induce much better protection than one. Water-based bacterins provoke less reaction and permit the inclusion of an antibiotic for treatment during an outbreak. However, a good water-based bacterin must contain a satisfactory adjuvant, or carrier, to be effective. The adjuvant controls the time of release of the antigen into the tissues. The presence of multiple strains, or types, in a bacterin is usually of less importance than having a strain of the cholera organism which is capable of stimulating protection that has both depth and breadth. Remember, though, an outbreak may still occur with any bacterin or vaccine, since none is perfect!

DID YOU HAVE ERYSIPELAS IN YOUR TURKEYS LAST SEASON?

If you did, you may wish to vaccinate with an erysipelas bacterin. Erysipelas vaccination is not generally practiced as a routine measure. However, when a farm is contaminated with the erysipelas organism, it may be necessary to vaccinate. As with cholera, the flock should be vaccinated twice for best results.

IS IT NECESSARY TO VACCINATE TURKEYS AGAINST NEWCASTLE DISEASE?

Turkeys are naturally more resistant to Newcastle disease infection, but the disease can be devastating if a severe challenge occurs in the field. Foci of infection are frequently present, so a potential challenge can exist. Vaccination, using B1-type virus (preferably one that is more virulent than the B1-strain) applied by the eyedrop method or drinking water is thus advisable.

It is preferable to give two vaccinations the first at 4-8 weeks of age and the last at 14-18 weeks. This can be adjusted to a time that the birds may be handled for other reasons or for the sake of convenience. Do not use the wing-web Newcastle disease vaccine virus, since the present-day B1-type strains are more suitable. Newcastle disease wing-web vaccines have, indeed, been used for many years, but the B1-type vaccines have rapidly succeeded them. B1-type vaccines may result in less stress, and they will generally stimulate ample protection.

While the preceding recommendations may serve as guides, remember that area, local and flock conditions vary considerably. Therefore, in any vaccination program, modifications are frequently needed. Poultry pathologists can help shape a program to your needs. We at Purdue University are most anxious to assist in any way possible.

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AVERAGE TEMPERATURES OF LIVESTOCK
IN DEGREES FARENHEIT

POULTRY	105-107
SWINE	102-103.6
GOATS	101.7-105.3
SHEEP	100.9-103.8
CATTLE	100.4-.02.8
HORSES	99.0-100.8

COMMON SANITARY CONDITIONS TO ESTABLISH

- Ventilation
- Space for Confined Livestock
- Manure Disposal
- Pasture Rotation
- Carcass Disposal
- Use of Disinfectants
- Control of Rodents and Birds
- Isolation of New Animals
- Vaccination
- Parasite Control

LESSON 14: LIVESTOCK MANAGEMENT PRACTICES

OBJECTIVES:

At the completion of the lesson the students will be able to:

1. Demonstrate methods of restraining animals to perform minor operations.
2. Demonstrate the methods for castrating livestock.
3. Demonstrate tail docking of lambs.
4. Demonstrate methods of dehorning cattle.
5. Demonstrate methods of clipping needle teeth in pigs.
6. Demonstrate the method of ringing swine.
7. Demonstrate debeaking poultry.
8. List different methods and equipment used to mark livestock for identification.
9. Demonstrate application of one method used for livestock identification.

MOTIVATION:

There are many minor livestock operations that have to be performed in an enterprise. Most of these require that you perform the activity to learn how to do the procedure. Select two students from the class. Have one student be the animal and the other the manager. Have the "manager" show how a rope restraint is to be placed on the "animal" by using the transparency master on rope restraints as a guideline.

REFERENCES:

The Science of Animal Husbandry, Reston Publishing Co.

Livestock and Poultry Production, Prentice Hall Publishing Co.

Transparency Masters: "Livestock Restraints"
"Restraints that Prevent Kicking"
"Casting and Restraining Methods"
"Restraining Sheep"
"Methods of Restraining Swine"
"Restraints of Horses"

"Castration Instruments"
"Bloodless Methods of Castration"
"Castrating Cattle"
"Castrating Sheep"
"Castrating Swine"
"Dehorners 1,2"
"Chemical Dehorning"
"Methods of Branding Livestock"
"Common Ear Marks"
"Ear Notch Numbering System"
"Tatooing"

OUTLINE:

A. Animal Restraints

1. Cattle

a. Tail Restraints (see transparency)
    1. grasp tail near base and apply pressure upward and forward while standing to side
    2. for treating nervous cow
b. Nose leads (see transparency)
    1. diverts animal's attention from area of pain to the pain caused by restraint.
    2. to examine body and feet, and for other management practices.
c. Grasping nostrils with thumb and forefinger.
    1. a less efficient method replacing a nose lead.
    2. same purposes as the nose lead.
d. Hobbles (see transparency)
    1. metal clasps fitting over hind legs above hock.
    2. prevent kicking
e. Squeeze Restraint (see transparency)
    1. rope loop around body in front of udder pulled tight while head is tied.
    2. causes animal to stand still.
f. Front leg hobble
    1. rope with eye in one end around pastern loose end passed over withers and held on opposite side.
    2. a front leg can be raised for inspection.
g. Trimming stock (see transparency)
    1. sling attached to beam on each side supports the weight of animal feet can be raised and securred.
    2. to trim hooves and other practices.
h. Beam Hook
    1. cow's head pulled to side opposite foot to be examined - rope looped and tied around cow's leg below fetlock-free end passed through hook on beam above and in back of cow-free end then passed down around same leg above hock and form a half hitch-secure rope forward on the stanchion.
    2. to examine and work on hooves or other operations.

i. Rope Casting (see transparency)
   1. place loop around animal's horns or neck then two half hitches made around animal's body behind shoulder and in front of hip bone-when rope is pulled animal will fall.
   2. to examine and work on hooves or other operations

j. Alternate method of casting (see transparency)
   1. 40 foot rope placed over back at withers and both ends brought through front of front legs-both ends brought up over back and crossed-bring both ends of rope out the back between the rear legs. Apply tension to ropes.
   2. can control direction animal will fall by way tension is applied-to examine and treat cattle.

k. Mechanical Squeeze Chutes and Head Gates
   1. contain small chute with entrance and exit gates-exit gate (headgate) contains panels that slide apart to allow head to enter and be fastened-side panels can be moved closer together to restrict body movement.
   2. Used for numerous management practices.

2. Sheep Restraints (Sheep can be securred by hand)

   a. Do not catch and hold sheep by pulling on wool, head or horns.
   b. To hold, stand on animal's left side, placing left hand under the jaw and right arm behind thighs.
   c. Other methods of hand restraint (see transparency).

3. Swine Restraints (see transparency)

4. Horse Restraints (see transparency)

B. Time of Castration

1. Cattle

   a. should be done on young calves (1-3 months of age)
   b. castration in late fall or early spring is best

2. Sheep

   a. castrated between 1-2 weeks old
   b. strict sanitary conditions are important

3. Swine

   a. castrated within 4 weeks of age
   b. not of same time as vaccination

4. Horse

   a. most owners prefer horse to be over 1 year of age for better muscular development.
   b. best to castrate in spring.
   c. should be performed by a veterinarian.

C. Methods of Castration

1. Surgical Removal with knife and scalpel (swine, sheep, cattle, horses)

   a. disinfect instruments
   b. remove lower (1/3) portion of scrotum or slit sides of scrotum
   c. slit the membrand covering each testicle
   d. sever cord by scraping with knife or clamping with emasculator
   e. apply fly repellent if needed and an antiseptic to the open wound

2. Bloodless Castration

   a. Burdizzo - used in castrating cattle and sheep
      1. crushes the cord and vessels
      2. work spermatic cord to side of scrotum
      3. clamp 1 1/2 - 2 inches above testicles
      4. leave clamped for 2 to 3 seconds
   b. Elastrator - used on smaller animals (young cattle and sheep)
      1. stretches a rubber ring over scrotum of young calves or lambs.
      2. ring cuts off circulation to testicles and causes them to atrophy and drop off

D. Dehorning Cattle

1. Mechanical Methods

   a. spoon and tube dehorners
      1. used on calves up to three months of age
      2. tube should fit over horn and cover 1/8 inch of skin around the horn
      3. a twisting action is made until skin is cut and a motion is made to cut under horn for removal
      4. spoon is used to gouge the horn out
   b. Elastrators
      1. rubber band placed over horns at hair line.
      2. used on horns 3-6 inches long
      3. results not as satisfactory as other methods
   c. electric dehorners
      1. used on calves after the button stage until 2-3 months of age.
      2. place over horn and hold firmly against head for 15 seconds destroying the horn growth cells
      3. horn sloughs off usually in 4 to 6 weeks
   d. dehorning coppers-heated with fuel
      1. can be purchased in different sizes
      2. works on horn same as electric dehorners
   e. barnes-type dehorners
      1. available in two sizes (4-8 month old calves) and (yearling and older)
      2. close handle to fit knives over horn
      3. position knives to remove a ring of skin with horn
      4. operator spreads the handles apart quickly to remove horn.

- f. dehorning clippers
  - 1. place opened blade over horn to remove 1/2 inch of skin with horn.
  - 2. operator quickly closes handles to remove horn
- g. dehorning saws
  - 1. cut deep enough to remove a ring of skin
  - 2. used on older cattle and on abnormally large horns
- h. on all mechanical dehorners except the types using heat, blood loss can be a problem and can be held to a minimum by using forceps to pick up the main artery on underside of cut. Pull artery until it breaks. The remaining part will retract into the soft tissue and stop the bleeding.

2. Chemical Method (see transparency)

   - a. use of chemicals to burn button
   - b. used on calves under 10 days old
   - c. chemicals used are caustic soda or potash in paste or stick form

3. Breeding with a polled bull

   Heriditary traits against horns can carry over to offspring.

E. Clipping Needle Teeth (swine)

1. Tools used-pliers

2. Needle teeth - eight small tusk like teeth-two on each side of upper and lower jaw.

3. Use pliers to clip only the tips of needle teeth to avoid injury to the jaw or gums.

4. Practice used to protect the sow's udder and each pig from injury.

F. Ringing (swine)

1. Used for hogs on pasture to prevent rooting.

2. Many types available - fish-hook type most common.

3. The rings are staple shaped and fit into special pliers.

4. To restrain swine for inserting see livestock restraints (small pigs can be hand held)

5. Rings are placed in the snout just back of cartilage but away from the bone.

G. Debeaking Poultry

1. Electrical - hot blade - cuts and cautarizes end of beak

2. Used on 1 day-1 week old chicks, some managers prefer it done later
3. Can remove upper or upper and lower 1/2 of beak on baby chick.
4. Use is to prevent cannibalism
5. Most commonly practiced on laying stock.

H. Livestock Identification Methods
   1. Ear Tags - semipermanent
   2. Neck Chain and Tags - semipermanent
   3. Brisket Tags - temporary
   4. Ear notches - semipermanent
   5. Hot hide brands - permanent
   6. Freeze brand - permanent
   7. Tatoos - permanent (placed inside lower lip or in ear)
   8. Paint brands - temporary
   9. Chalk marks - temporary
   10. Paper back tags - temporary
   11. Dewlap notches - semipermanent
   12. Horn brands - semipermanent
   13. Ankle bracelet - temporary
   14. Tail bracelet - temporary
   15. Tail bob - semipermanent
   16. Wottles (remove meat out of cheek) - semipermanent
   17. Buds (x in nose forms buds) - permanent

I. Information to record at birth
   1. Birth date
   2. I.D. marking of animal or litter
   3. Sire I.D.
   4. Dam I.D.

- f. dehorning clippers
    - 1. place opened blade over horn to remove 1/2 inch of skin with horn.
    - 2. operator quickly closes handles to remove horn
- g. dehorning saws
    - 1. cut deep enough to remove a ring of skin
    - 2. used on older cattle and on abnormally large horns
- h. on all mechanical dehorners except the types using heat, blood loss can be a problem and can be held to a minimum by using forceps to pick up the main artery on underside of cut. Pull artery until it breaks. The remaining part will retract into the soft tissue and stop the bleeding.

2. Chemical Method (see transparency)

- a. use of chemicals to burn button
- b. used on calves under 10 days old
- c. chemicals used are caustic soda or potash in paste or stick form

3. Breeding with a polled bull

Heriditary traits against horns can carry over to offspring.

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I. Information to record at birth

1. Birth date
2. I.D. marking of animal or litter
3. Sire I.D.
4. Dam I.D.

5. Sex

6. Birth weight

7. Ease at birth

8. Special color and other markings

TEACHING LEARNING ACTIVITIES:

1. Have students list different methods used to restrain livestock. Discuss why one method of restraint would be better than another for a specific operation. Use the transparencies to aid in the discussion.

2. Have castrating equipment on display for students to view. Discuss the different methods used for castration. Discuss reasons for castrating livestock and point out some of the disadvantages that should be considered.

3. Ask students why the docking of lamb's tails is used. Describe the methods used for docking.

4. Have students use reference sources to list the different methods used to dehorn cattle. During discussion show the different types of equipment used to dehorn cattle.

5. Explain that some young animals will injure each other in crowded conditions such as in cattle with horns. What are some other injury problems found with other types of livestock. (cannibalism in swine and poultry). Discuss how and why the needle teeth in swine are removed and why poultry are debeaked.

6. Ask students what operation is performed on swine to keep them from rooting. (Ringing) What is the purpose for ringing swine. Show the equipment used for ringing.

7. One of the greater management expenses in livestock programs is from animal identification. What are some methods used to identify and mark animals? List the methods provided by the students on the chalk board. Discuss which methods are the best for specific purposes. Provide samples for the students examination. Have students review references on how to read ear notches and numbering systems.

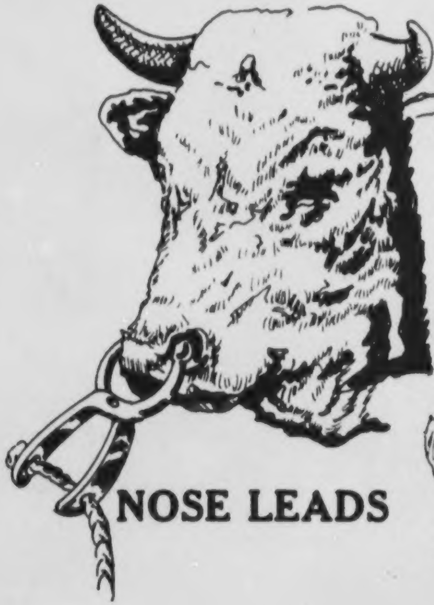
8. Arrange a field trip with a livestock producer to view his operation during the time of some management operation. If possible, arrange to have the students involved in restraint and the operation that is taking place.
   a. An example might be in catching cattle in squeeze chute and sticking in ear tags or castration of baby pigs. Extreme care should be taken with sanitation and close supervision during the operation.
   b. An alternative would be to provide students each an opportunity on their own farm or a neighbor's or employer's operation. Students could pair up-(those that have work to do with those that do not) to gain experience. Teacher and owner supervision with pictures should be used or verification by the livestock owner should be recorded to verify

completion of assignment.

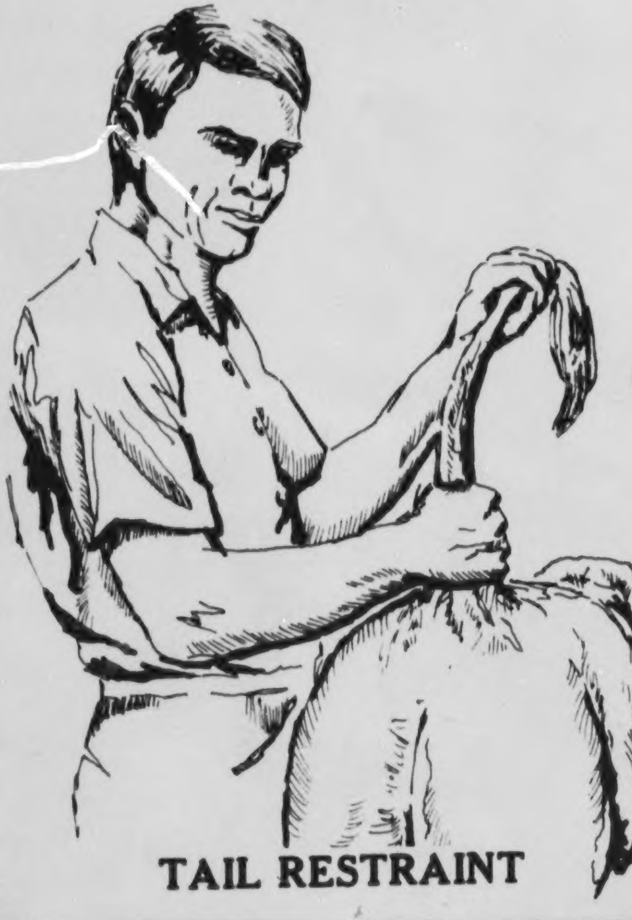
SUGGESTED EVALUATION:

1. Provide a written test on methods and equipment discussed.
2. Evaluate the students on their procedures of performing operations.

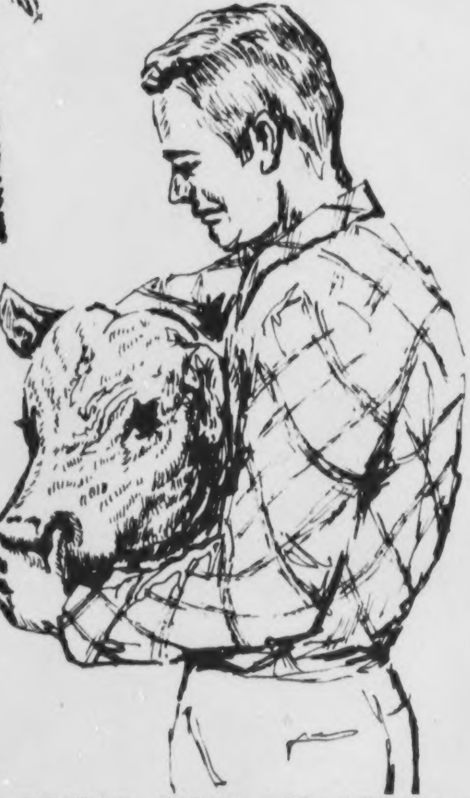
LIVESTOCK RESTRAINTS



NOSE LEADS



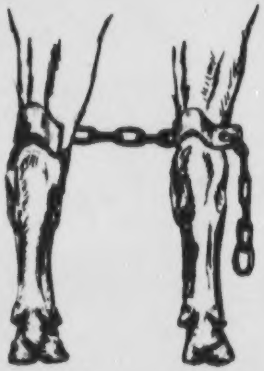
TAIL RESTRAINT



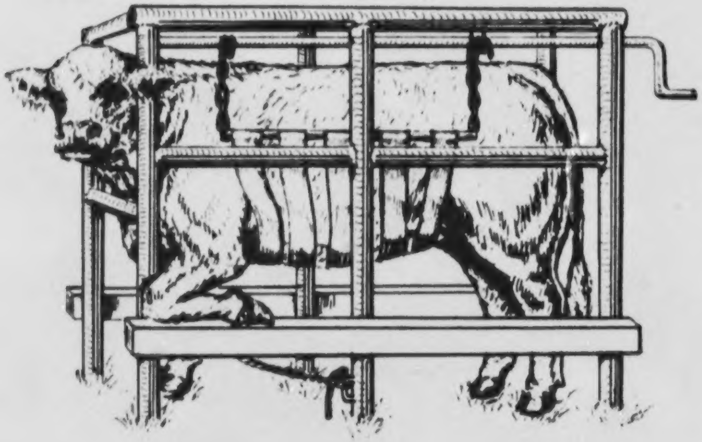
GRASPING THE NOSTRILS

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

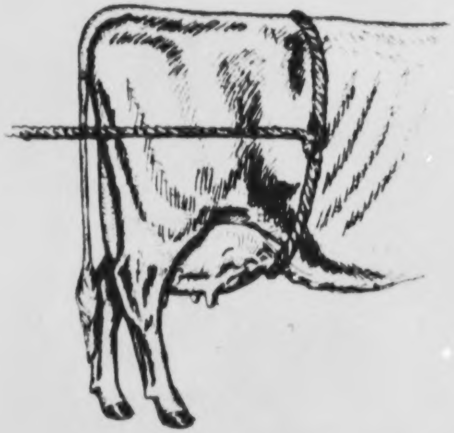
RESTRAINTS THAT PREVENT KICKING



HOBBLES



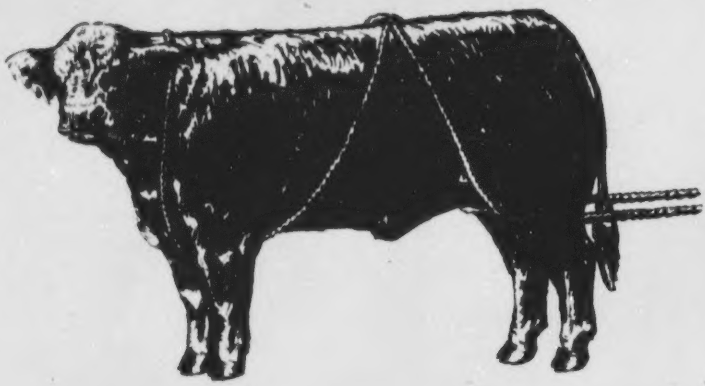
TRIMMING STOCK



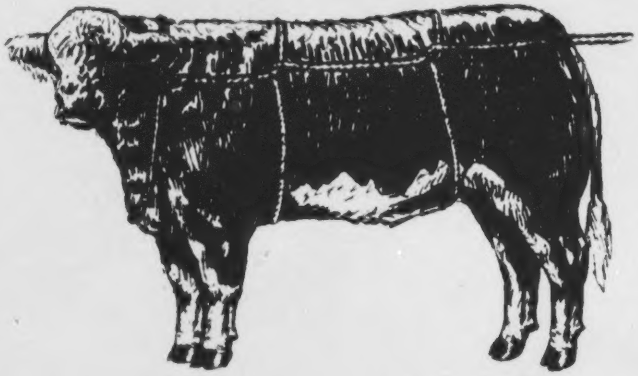
SQUEEZE RESTRAINT

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

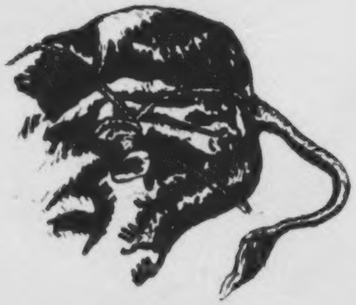
CASTING AND RESTRAINING METHODS

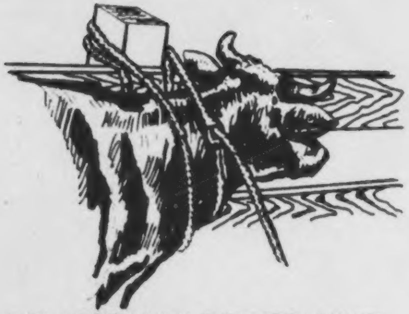


BURLEY METHOD OF CASTING AND RESTRAINT



ROPE METHOD OF CASTING



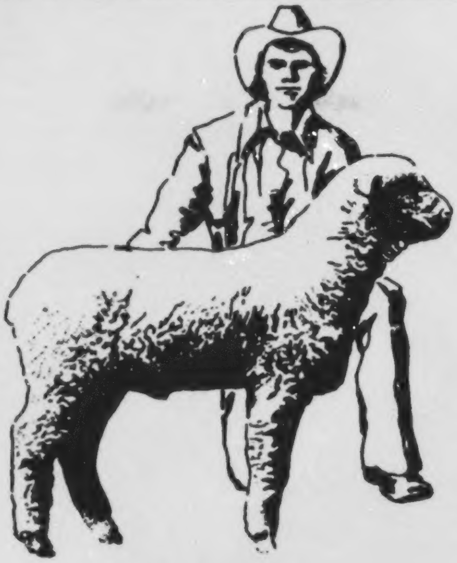


DEHORNING RESTRAINT

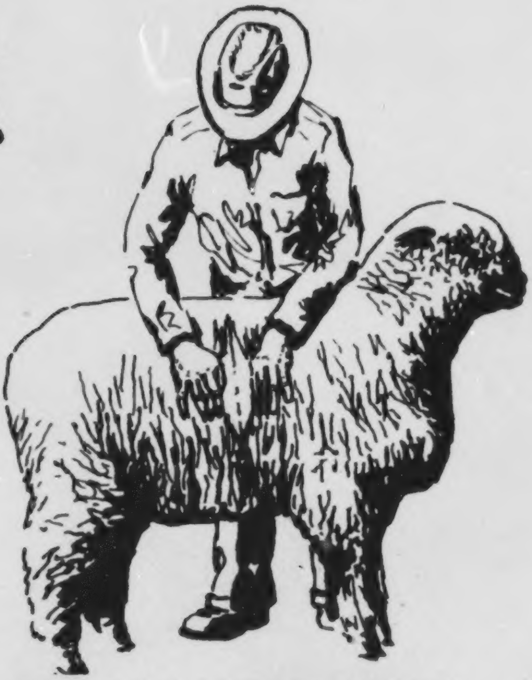
Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

VI-166 T

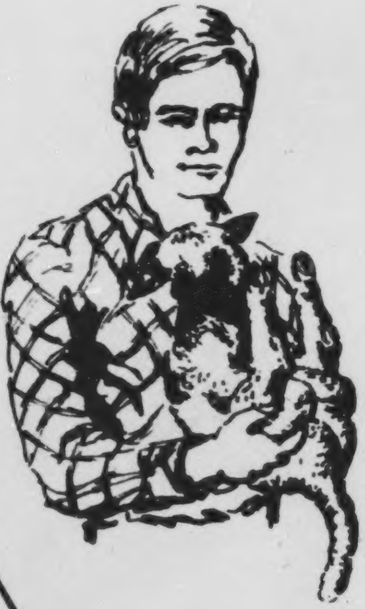
RESTRAINING SHEEP



HOLDING



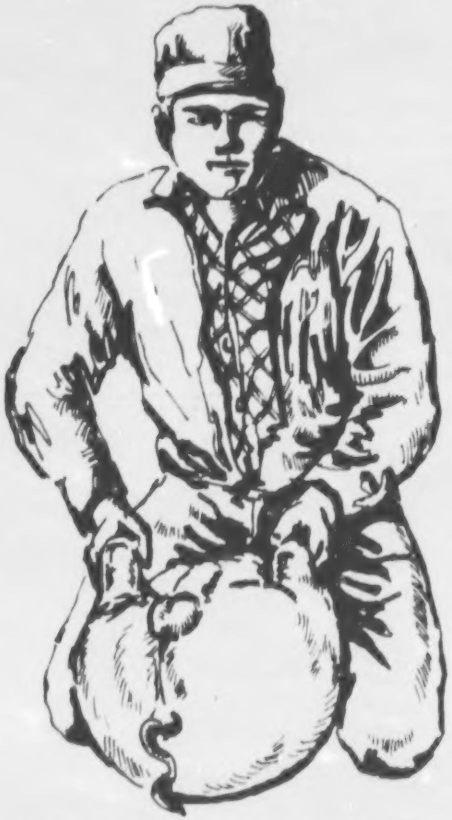
FLEECE INSPECTION



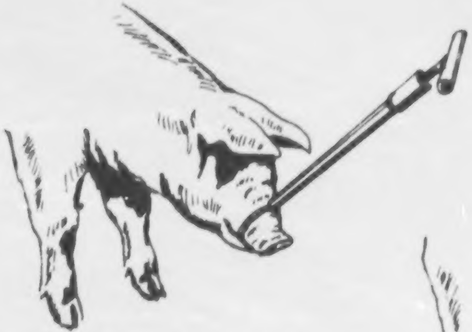
DOCKING AND CASTRATING

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

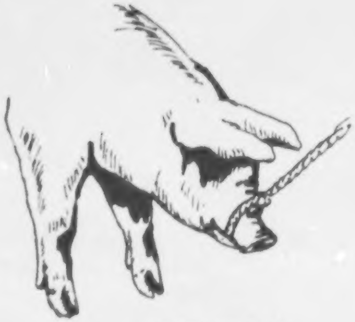
METHODS OF RESTRAINING SWINE



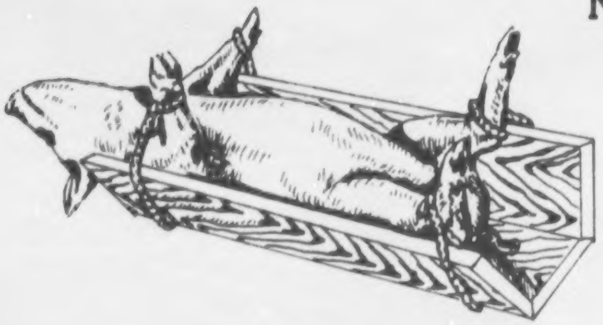
HAND RESTRAINT



COMMERCIAL HOG HOLDER



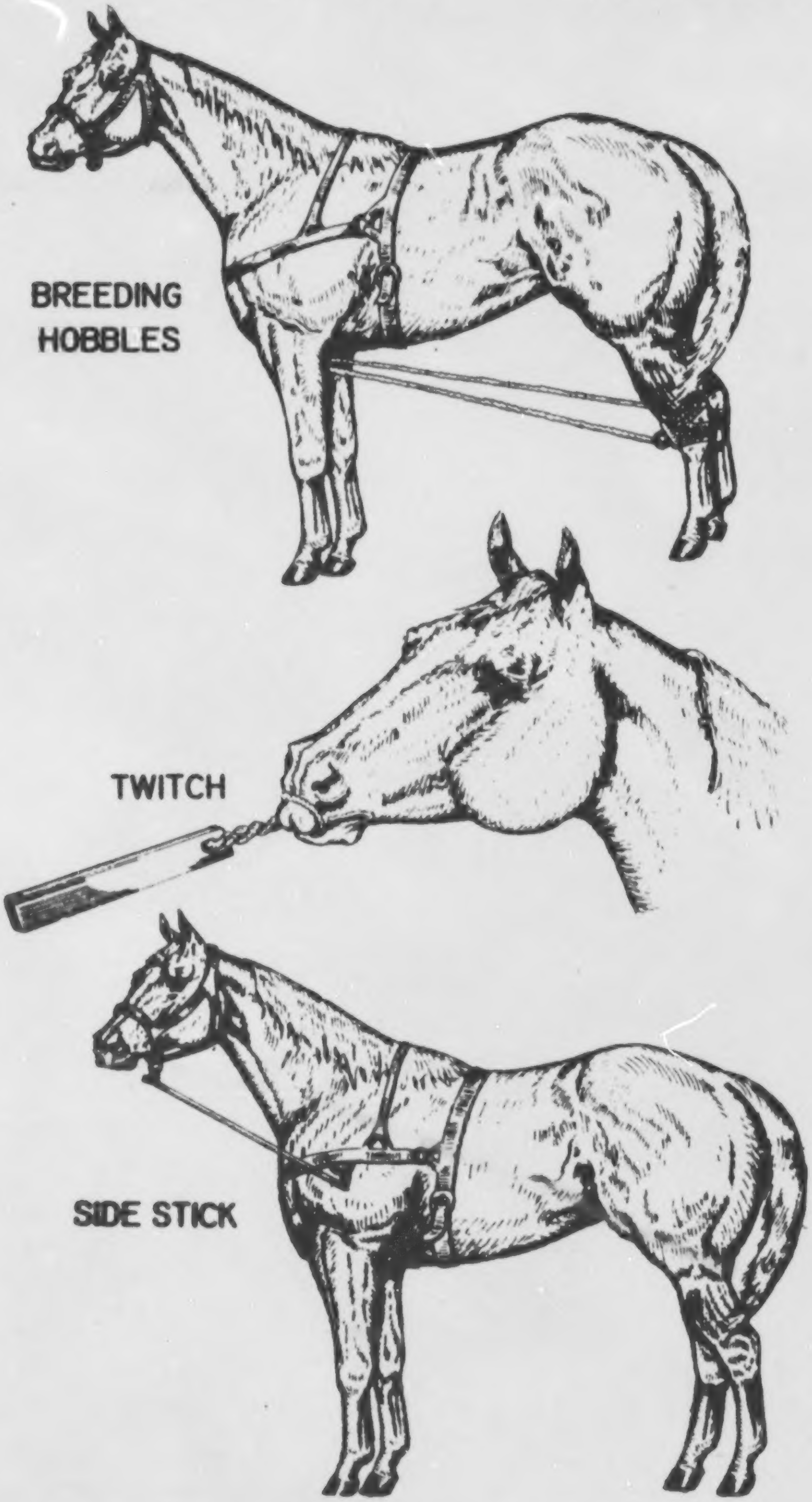
NOOSE



PIG RESTRAINING TROUGH

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

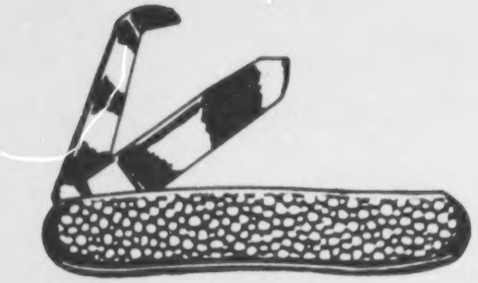
RESTRAINTS OF HORSES


BREEDING HOBBLES
TWITCH
SIDE STICK

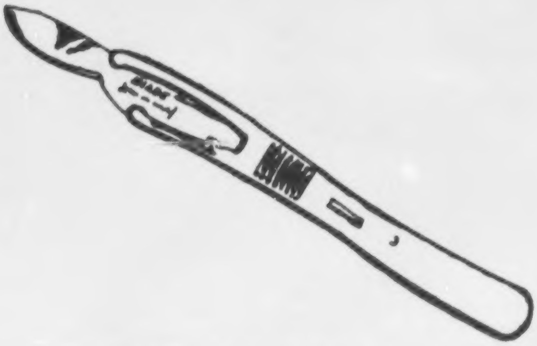
Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

VI-169 T

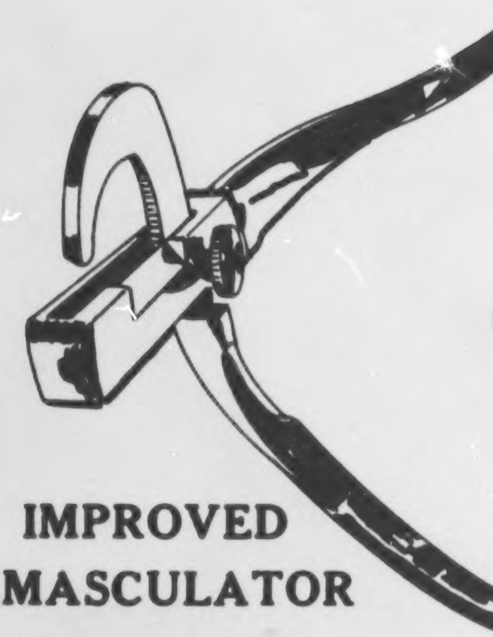
CASTRATION INSTRUMENTS



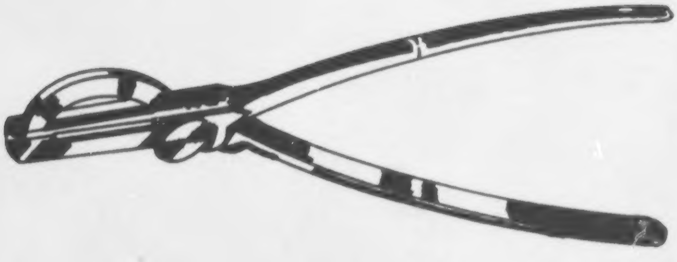
CASTRATION KNIFE



CASTRATION SCALPEL



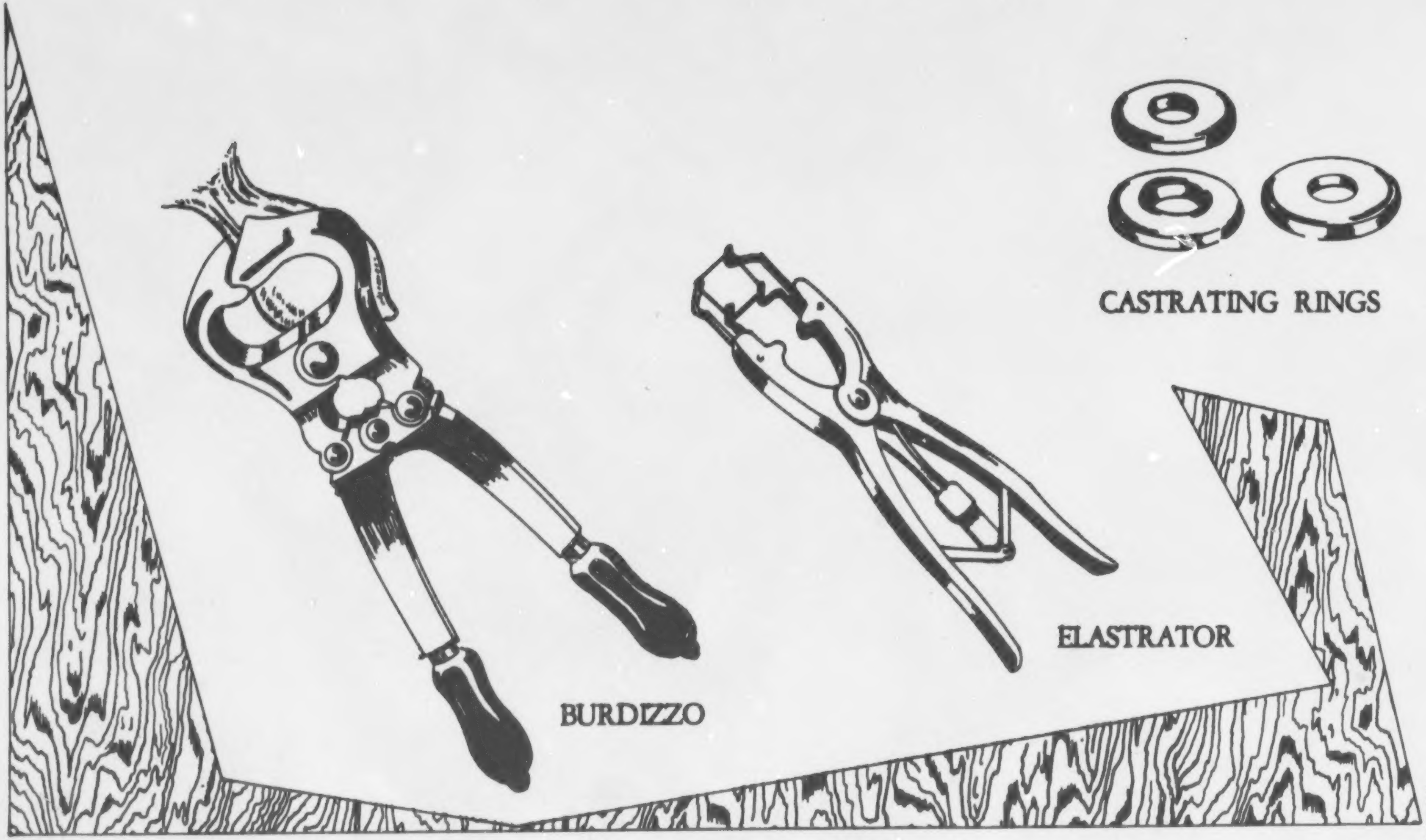
IMPROVED EMASCULATOR



PLAIN EMASCULATOR

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

BLOODLESS METHODS OF CASTRATION

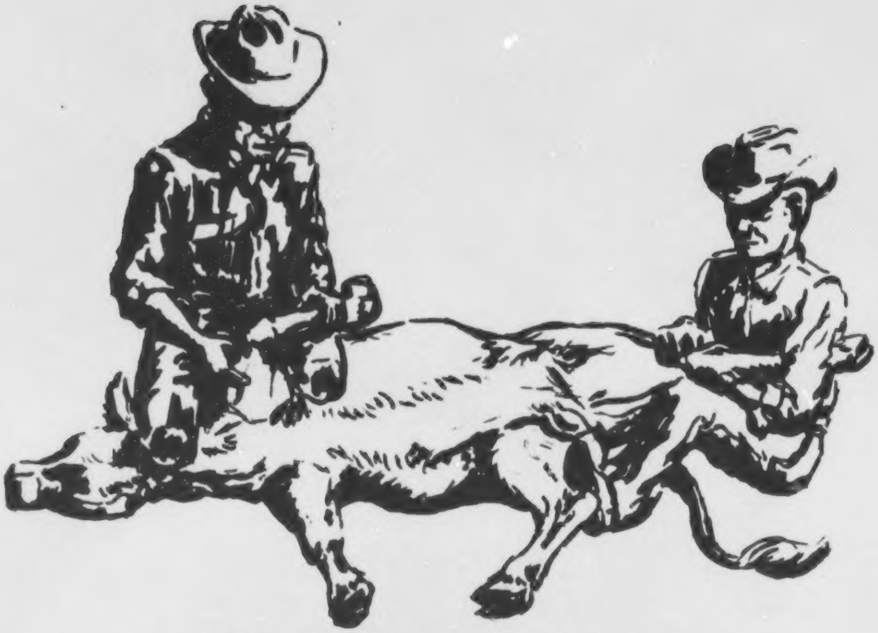

CASTRATING RINGS
ELASTRATOR
BURDIZZO

VI-170 T

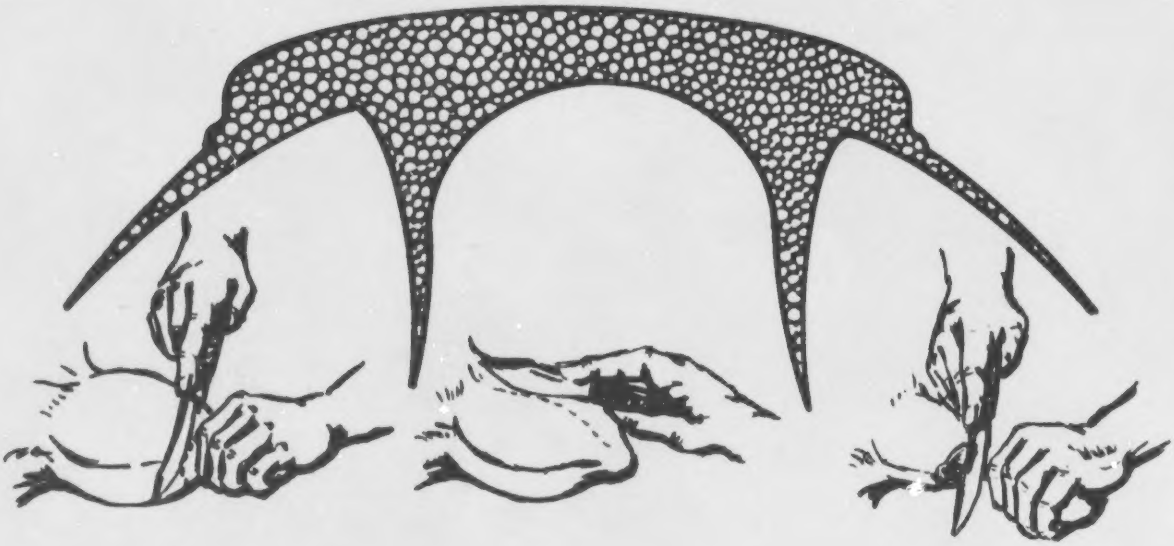
Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

VI-171 T

CASTRATING CATTLE



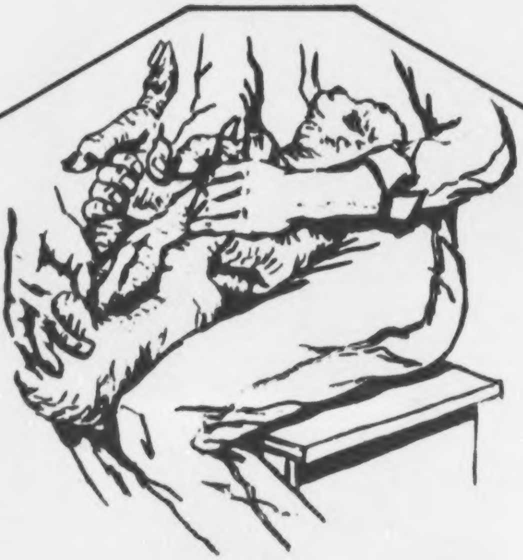
CASTRATING RESTRAINT



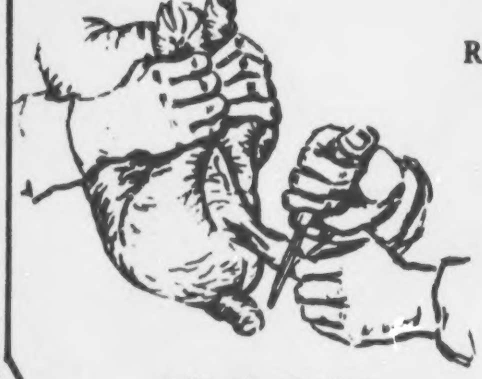
CASTRATING WITH A KNIFE

Courtesy of Vocational Instructional Services
Texas A & M University
College Station, Texas 77843

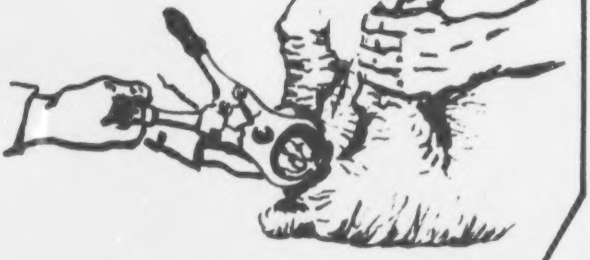
CASTRATING SHEEP



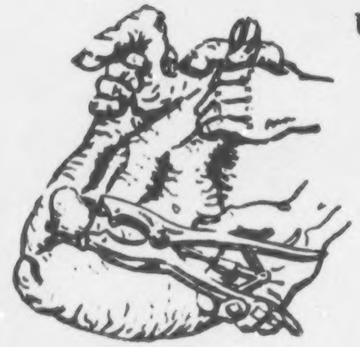
RESTRAINT



USE OF KNIFE



USE OF BURDIZZO



USE OF ELASTRATOR

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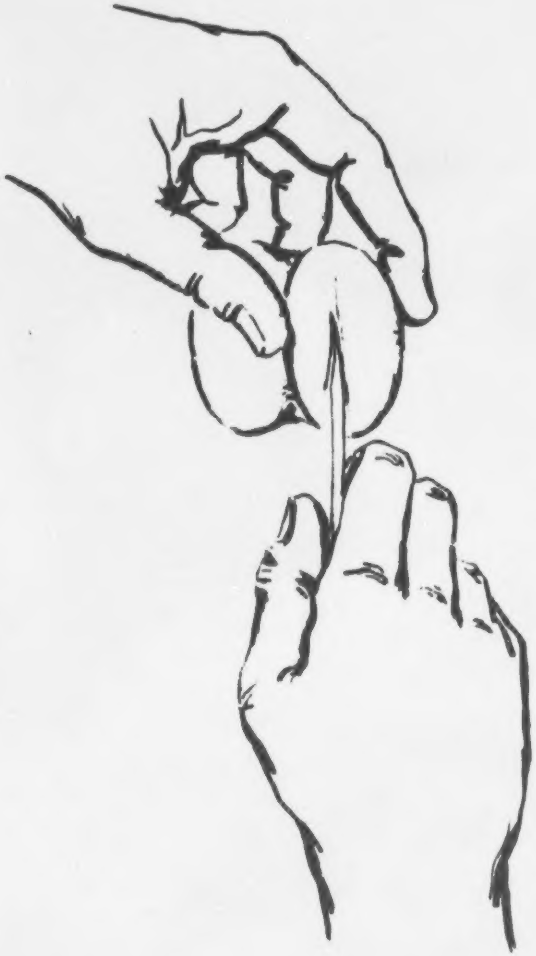
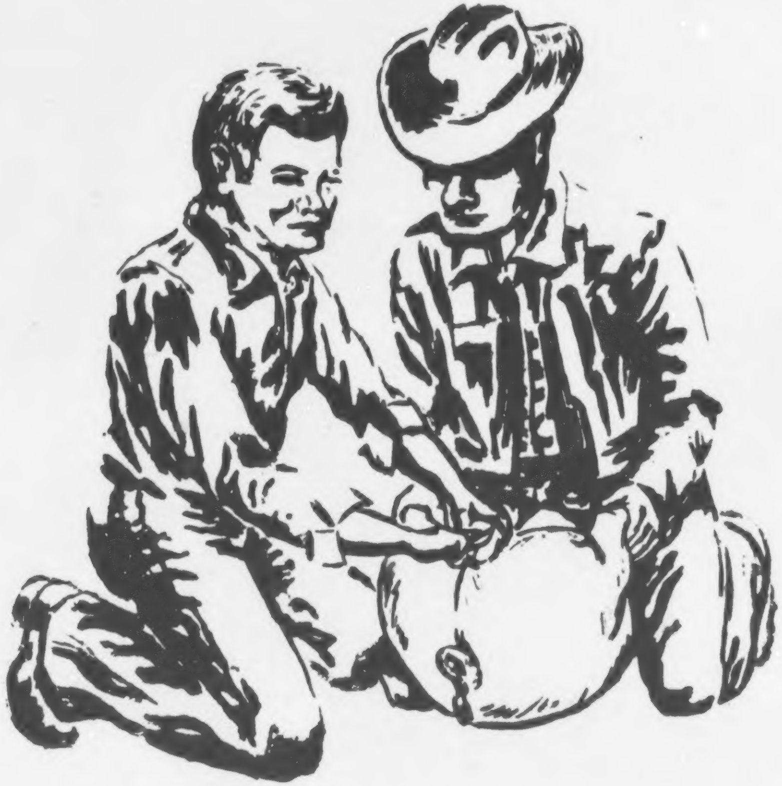
CASTRATING SWINE



REMOVING TESTICLE



RESTRAINT

VI-173

Courtesy of Vocational Instructional Services
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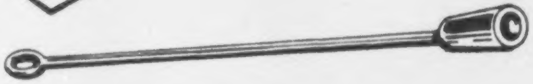
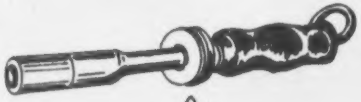
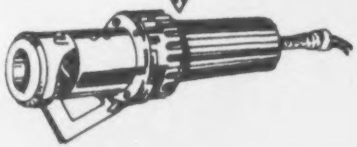
DEHORNERS



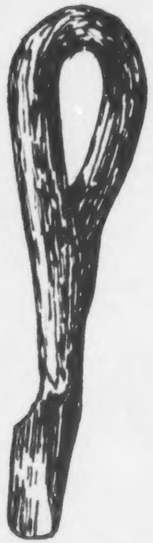
hot iron



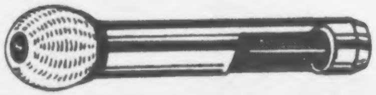
electrical



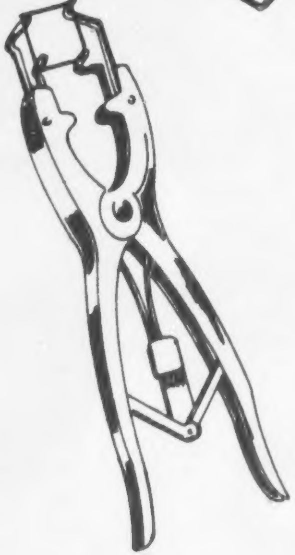
DEHORNING IRONS



METAL SPOON OR GOUGE



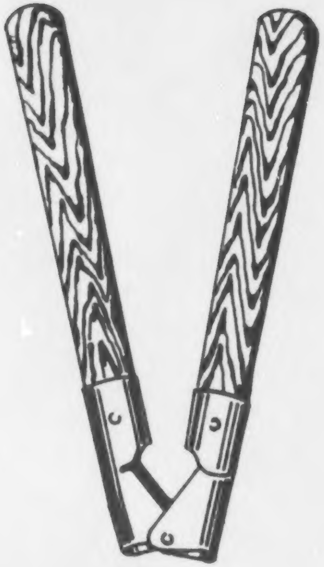
TUBE DEHORNER



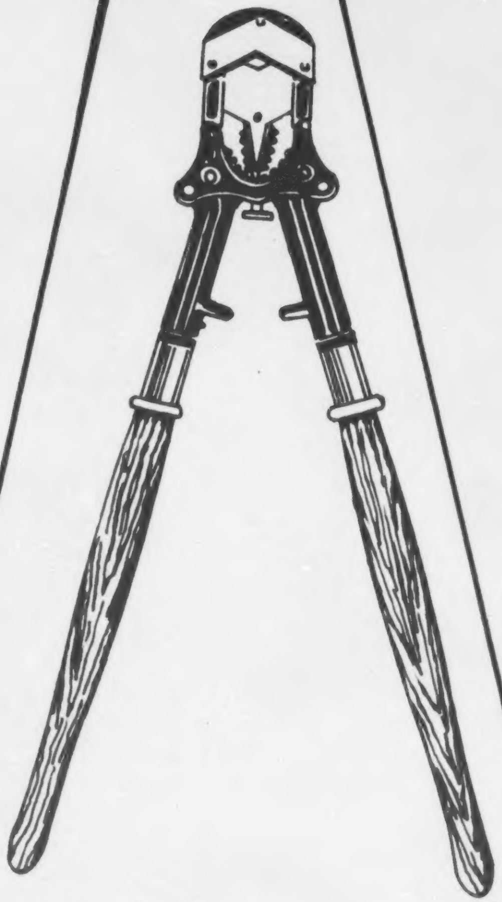
ELASTRATOR

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

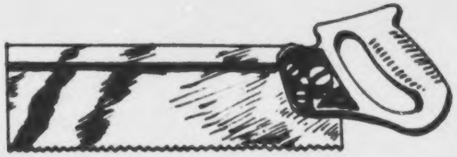
DEHORNERS



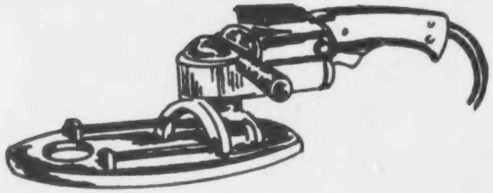
"BARNES TYPE" DEHORNER



DEHORNING CLIPPERS



hand



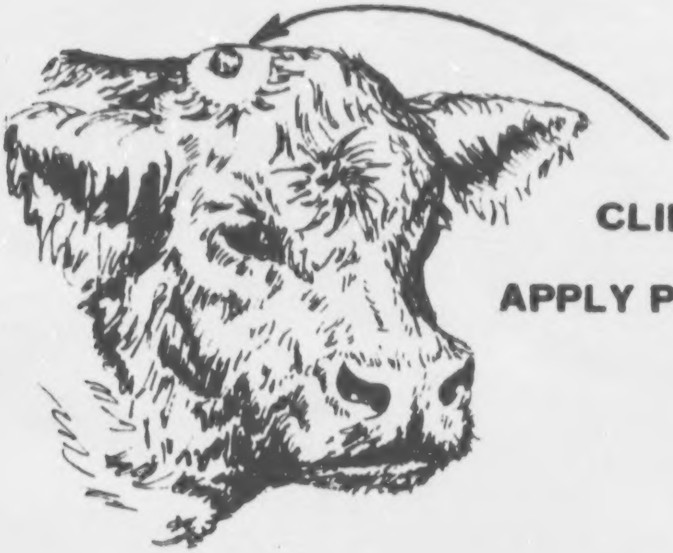
electrical

DEHORNING SAWS

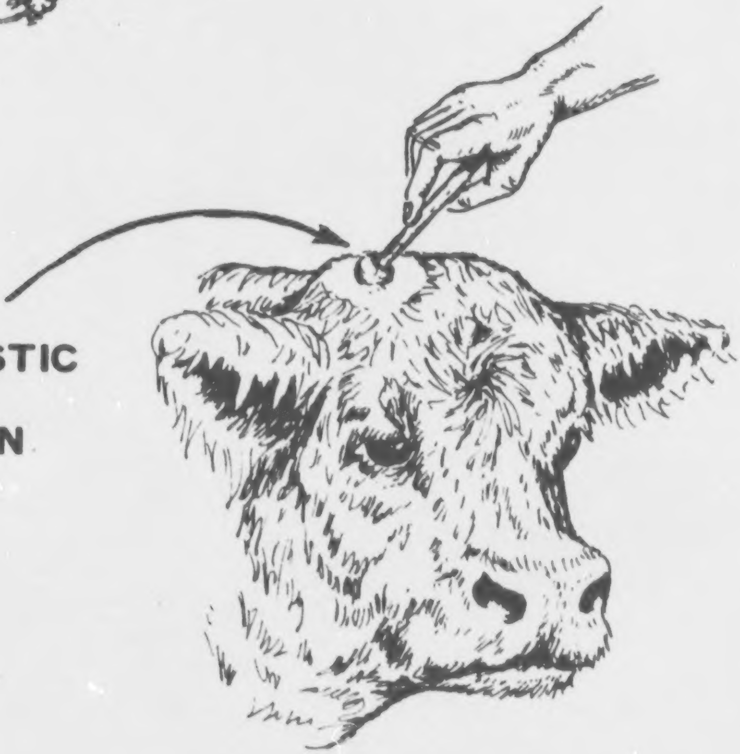
VI-175 T

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

CHEMICAL DEHORNING



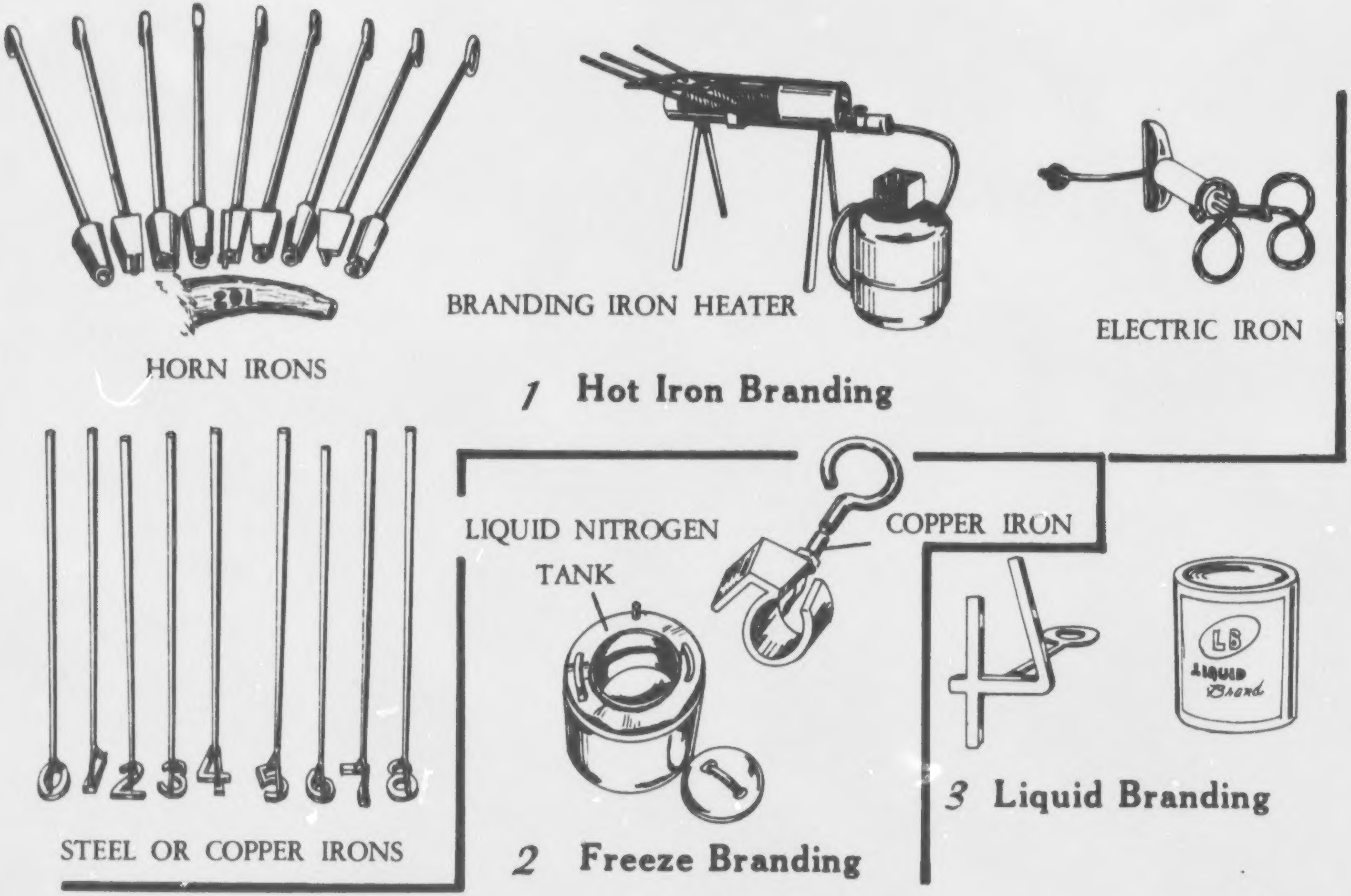
CLIP HAIR &
APPLY PETROLATUM



APPLY CAUSTIC
TO BUTTON

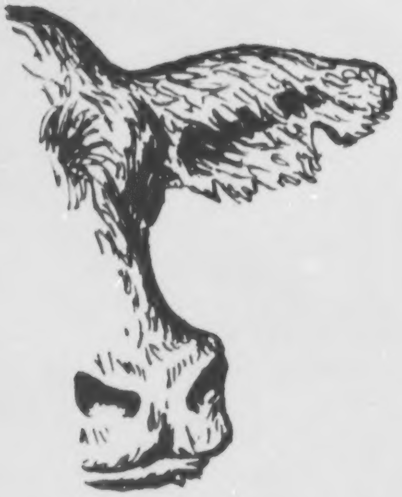
Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

METHODS OF BRANDING LIVESTOCK

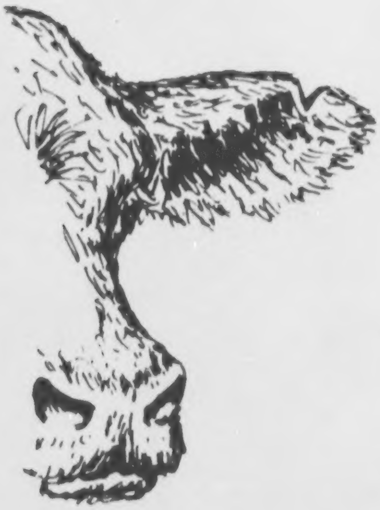

HORN IRONS
BRANDING IRON HEATER
ELECTRIC IRON
1 Hot Iron Branding
0 1 2 3 4 5 6 7 8
STEEL OR COPPER IRONS
LIQUID NITROGEN TANK
COPPER IRON
2 Freeze Branding
LB LIQUID Brand
3 Liquid Branding

Courtesy of Vocational Instructional Services
Texas A & M University, College Station, Texas 77843

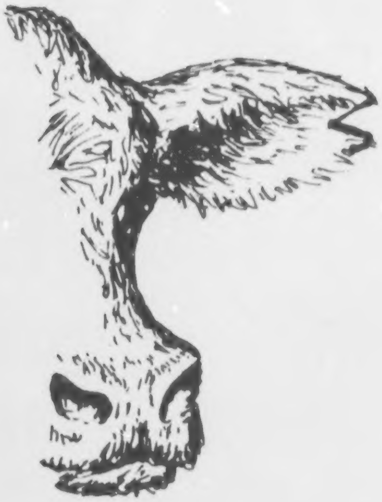
COMMON EAR MARKS



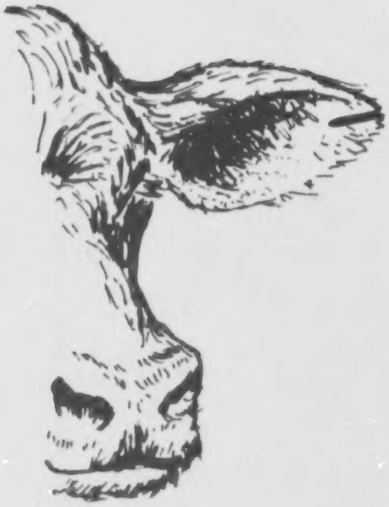
UNDER BIT



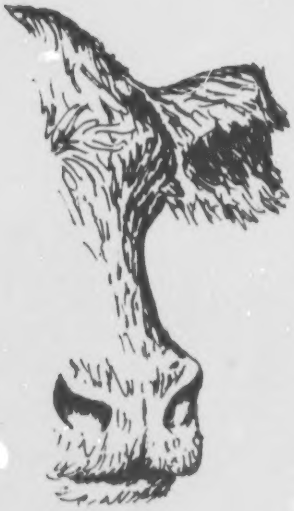
OVER BIT



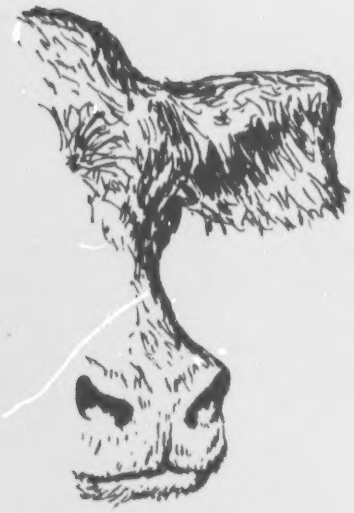
SWALLOW FORK



SPLIT



BOBBED



TIPPED

Courtesy of Vocational Instructional Services
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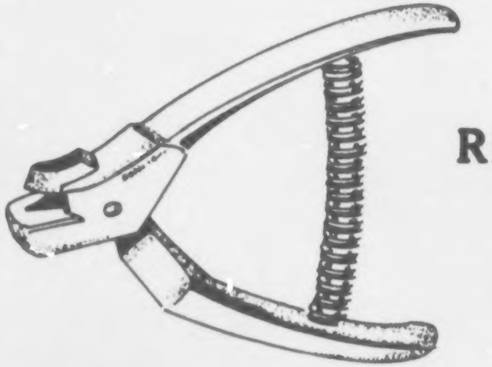
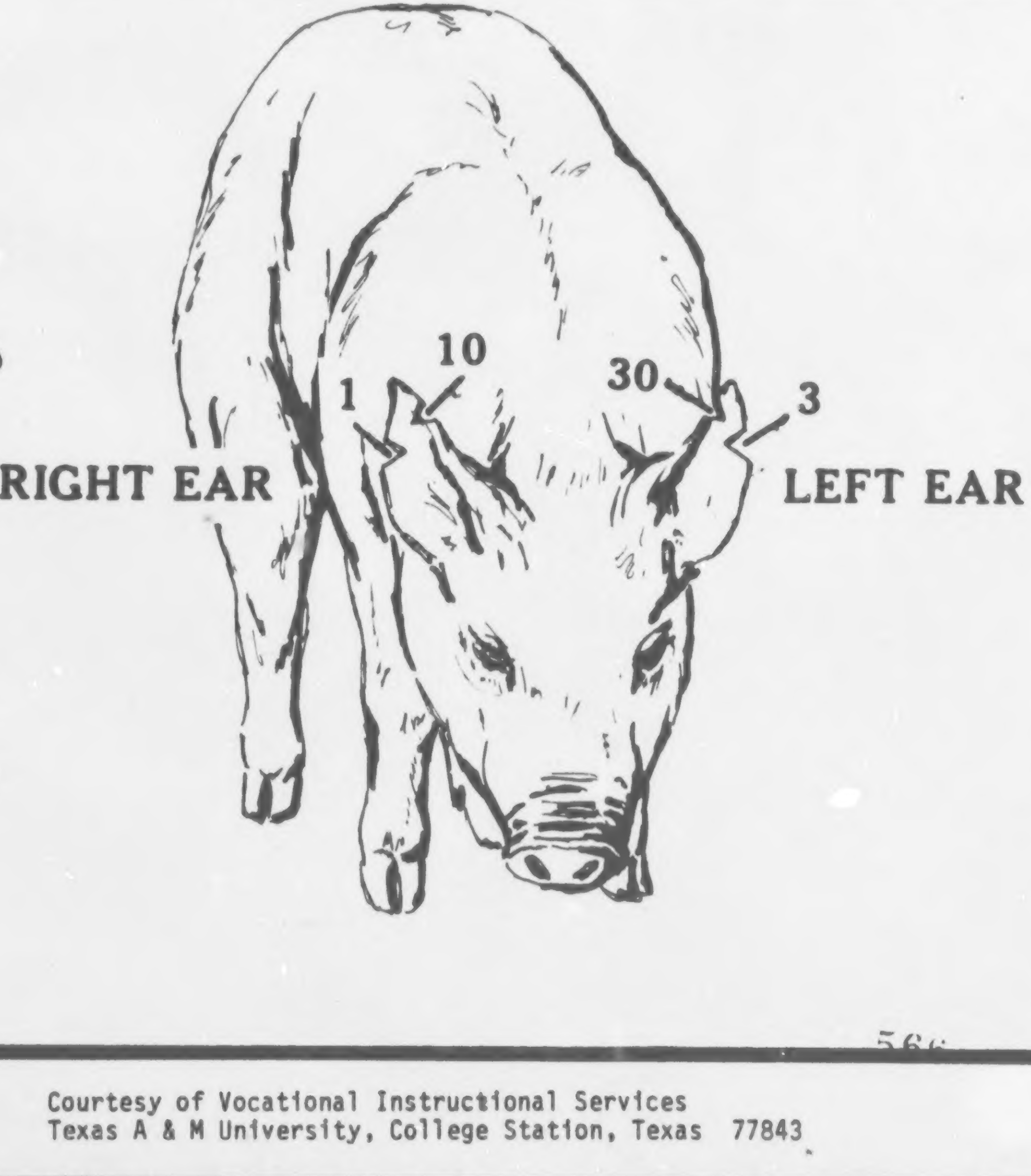
EAR NOTCH NUMBERING SYSTEM



EAR NOTCHERS


10
1
30
3
RIGHT EAR
LEFT EAR

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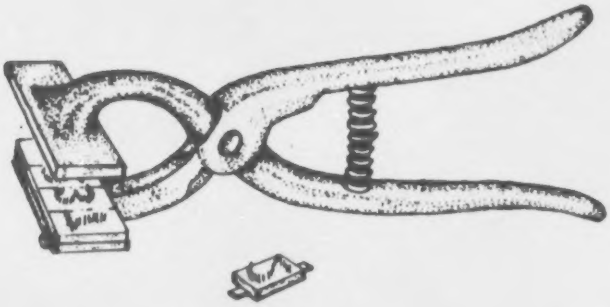
TATTOOING



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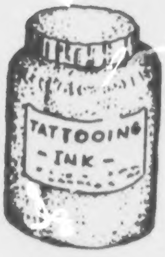
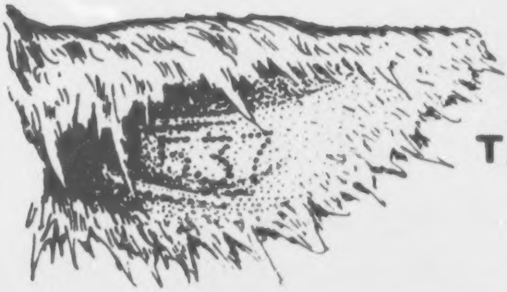
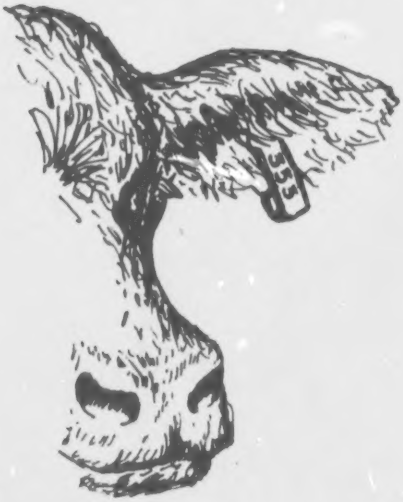


TATTOO INK

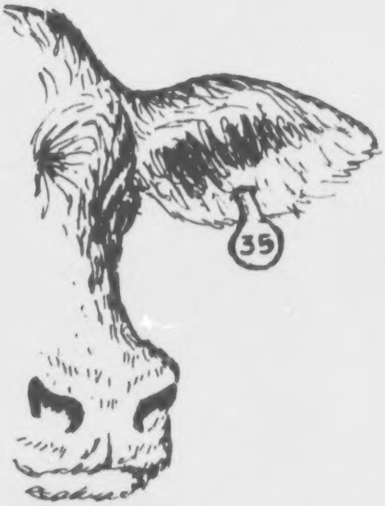


TATTOO IN EAR

EAR TAGGING



METAL OR PLASTIC TAG



RUBBER TAG

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LESSON 15: FITTING AND SHOWING

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Demonstrate procedures used to train an animal to stand tied.
2. Train an animal to lead.
3. Trim hooves in preparation for exhibition.
4. Clip and groom selected livestock for exhibition.
5. Demonstrate showmanship procedures for selected types of livestock.

MOTIVATION:

If possible, plan a field trip to a livestock show or to a registered livestock breeder that travels on a livestock show circuit and review methods of fitting and showing livestock.

REFERENCES:

Beef Production, Prentice-Hall Publishing Co.

Dairy Production, Prentice-Hall Publishing Co.

Swine Production, Prentice-Hall Publishing Co.

The Horse, W. H. Freeman and Company

OUTLINE:

A. Fitting and Showing Beef

  1. Training

    a. start with young calf
    b. gentle the calf by brushing and petting (requires patience)
    c. tieing-halter and rope-tie so animal will not become entangled
    d. leading
      1. never allow animal to break loose
      2. use a rope halter and later use leather show halter and lead from the left with lead strap coiled in right hand.
      3. sometimes turning the animals head will induce it to walk.

   4. If danger of animal getting loose- attach one rope to a tractor and move tractor only as animal is being lead by showman.
- e. position the animal
   1. all four feet squarely under it with head level with back and back straight.
   2. stand facing animal with the lead strap in left hand.
   3. use a four foot long show stick to line up hind feet.
   4. use foot to line up front feet.
   5. stand animal (if possible) where front feet are slightly higher than hind feet.
   6. if swayback pinch on rump midway back from hips
   7. if humpback pinch in middle of back

2. Trimming Hooves

   a. trim regularly for proper standing and walking.
   b. trim at least one month before show.
   c. trim off large portions of hoof with nippers, trim bar (hard material on outer edge of sole on hoof) with hoof knife, even up and remove smaller amounts with rasp or electric rotary sander.
   d. smooth hooves with rotary sander or broken glass and finish with steel wool.
   e. polish hooves with olive oil or other polishes.
   f. correct post legged-remove hoof material from heel
   g. correct sickle hocked-remove hoof material from toe.
   h. correct cow hocked or toed out-trim the bar on outside of hoof.
   i. correct toed in or pigeon toed-trim bar on inside of hoof.

3. Horn Training and Polishing

   a. use commercial horn weights-start when horns 2-3 inches long if direction and curve is incorrect.
   b. scrape and polish the horns - see trimming hooves (2. d&e)

4. Grooming

   a. daily with brush
   b. use curry comb to remove dirt particles.

5. Washing

   a. wash weekly at least one month before show
   b. scrub with warm water and lather forming soap and rinse with warm water

6. Clipping

   a. clip head 3-5 days before show.
   b. do not clip ears, eye lashes, muzzle
   c. clip 2 finger distance behind ear
   d. clipping requirements different breeds

Breed	Clipping of Head
Horned Herford	none
Polled Herford	clip pole only
Charolais	none
Shorthorn	none
Exotics	full cut
Angus	full cut or facing out (front of face-used in winter shows)

e. clipping brisked with direction of hair
f. belly-front of navel toward head and blend in by clipping loose hair up from belly.
g. flank-clean up the outline.
h. tails-important to look natural and blend in-clip with sheep shears-clip down to where twist breaks off.
i. shoulder-smooth up the elbow
j. stifle-leave or little if any clipping
k. rear quarter-small amount of clipping between hock and stifle using sheep shears or small clippers.
l. pull hair up around tail head
m. clean out between rear legs
n. top-clip for a rounded appearance
o. neck-take out crest and shave down neck
p. bone out legs-fluff hair up on cannon bones
q. rear quarter-fluff hair up
r. switch-should tease the hair up on switch

B. Dairy

1. Training - see beef outline (animal practices b&c are same for Dairy)

    a. leading
        1. training to lead see beef 1, 3 and 4
        2. lead so that judge is in view at all times-same for beef.
        3. lead from right holding lead strap in right hand four inches from halter or walk backwards and hold lead strap in left hand.
    b. position the animal
        1. bring animal to rest slowly
        2. try to have front feet on higher ground than hind feet
        3. hold the head up
        4. should have animal's front feet wide apart and one hind foot back of the other.
        5. turn head of animal toward judge when he inspects the hide.

2. Trimming Hooves - see beef outline.

3. Horn Training and Polishing - see beef outline.

4. Grooming - see beef outline.

5. Washing - see beef outline

6. Clipping

   a. head-clip face, poll, and ears except Ayrshires-leave ring of hair around horns and Brown Swiss ears are not clipped.
   b. neck-some breeders clip entire neck-clip top of neck when hair is short.
   c. underline and udder-clip around milk veins, udder, and flanks.
   d. tail-clip from one to two inches above switch to point where tail head joins the body.

C. Fitting and Showing Swine

1. Exercise

   a. if confined-to improve feet and legs and trim the middle.
   b. walk hogs early in morning or late of day (cool weather) 1/4 to 1/2 mile each day.

2. Training

   a. use short cane or whip to give commands
   b. tap on back to get hogs to move
   c. tap on nose to stop
   d. tap on left to turn right
   e. tap on right to turn left
   f. experiment to find how to show strong points and minimize weaknesses
   g. train to stand squarely on feet with backs up and heads down

3. Trimming Feet - see beef outline.

4. Removing Tusks and Rings

   a. remove rings well ahead of show
   b. remove tusks from mature boars-make smooth cut with a bolt cutter or pair of nippers.

5. Clipping

   a. clip inside and outside of ears
   b. clip tail from base to switch
   c. sometimes mature animals entire body clipped several months before show to allow new hair coat to grow by show time

6. Washing - several times in advance of show with soap and warm water

7. Brushing - brush regularly

8. Oiling

   a. many shows will not permit
   b. use sparingly on red and black breeds

9. Powdering

   a. many shows will not permit
   b. use on white breeds

   Note: The National Barrow Show prohibits powdering, oiling, or any dressing of hogs other than washing.

D. Sheep

1. Grooming

   a. clean fleece-use in tank of water with some soap at least one month prior to show.
   b. if fleece is not very dirty much of dirt will be removed by trimming if fleece is first wet down and raked with circular curry comb, carded and then trimmed.
   c. once cleaned cover fleece with clean blanket.

2. Trimming feet - trim the bar down even with soul using hoof knife.

3. Trimming Fleece

   a. place the sheep on the trimming table and brush the fleece to remove the dirt.
   b. dampen the fleece with water. A mild solution of an acceptable sheep dip will help to clean and straighten the fibers.
   c. comb the entire fleece with the circular comb to remove the dirt on the outer ends of the fibers.
   d. card the fleece with the wool card to straighten out the fibers and break up the fleece.
   e. trim off the rough carded wool until a smooth surface is obtained. The fleece will trim easier if it is damp.
   f. steps in trimming -
      1. trim the top to the width of the sheep's back with the points of the shears toward the outside.
      2. trim the sides with the points of the shears up until the proper shape is obtained.
      3. square the dock and trim the twist and rear legs. It is best to trim up rather than down. Do not take off much wool in this area.
      4. trim up the brisket and shoulders.
      5. trim the head and neck according to breed type.
   g. pack the fleece with the back of a dampened wool card after trimming is completed.
   h. place a clean blanket on the sheep until the next trimming.

   Note: 1) One of the secrets of a good job of trimming is to keep the blade next to the fleece stationary while the other blade pulls the fibers over it. This is developed with practice. A much smoother job is obtained than when both blades are moved. Start at one end of the area to be trimmed and move slowly and deliberately to the other end without lifting the shears from the fleece. Nicks develop when the shears are lifted from the surface.

2) It will be necessary to go over the sheep two or three times to get a smooth job of trimming. Do not remove a lot of wool at any one time. A number of short trimmings are preferable. The last job of trimming should be done either on the day of the show or the day previous, after the fleece has had time to set from the first trimmings.

4. Showing Sheep

   a. held by wool and loose skin under chin.
   b. place hand on dock when moving sheep.
   c. set legs square at corners but do not allow animal to stretch.
   d. keep sheep between judge and showman at all times and far enough away from other sheep so judge gets a good view.
   e. hold animal's head slightly high in normal position.

E. Horses - This outline will only cover grooming and training the colt to lead. Many breeds vary in showing requirements and should be reviewed separately. If possible by trainers of different breeds.

1. Training the Colt to Tie and Lead

   a. Gentleing - rubbing and petting to ease fears of the colt.
   b. Tieing - use a leather colt halter - and tie close to keep colt from becoming entangled in tie rope.
   c. Leading - attach two lead ropes to colt. Using two people - one close to halter and the other further away as a safety to prevent animal from breaking loose. Lead the colt slowly. Turn the colt's head to get started moving. Reward the colt's movement by petting or rubbing and calming it. Prevent colt from rearing to hind feet. Lead only for a short time each day.
   d. Overcoming fear of movement and noise - Use a paper feed sack or other similar material. At first, gently rub the colt with the object, gradually increasing the roughness and speed of rubbing all over the colt's body. Do this regularly using different materials.

2. Handling Feet

   a. start by rubbing the leg and making colt aware of your pressence.
   b. left front leg - face colt's rear, place left hand against colt's shoulder, run the right hand down the forearm past the knee and cannon bone to pastern. Apply pressure up and back.
   c. use same procedure on other side only reverse hands.
   d. hold foot and rub the colt's leg.
   e. rear right leg - place hands on rear quarter and use same procedure of lifting as for front leg.
   f. raise feet regularly to prepare colt for being shod.

Note: The listed procedures will prepare colt for shoes and equipment by getting it calmed and easy to handle.

TEACHING LEARNING ACTIVITIES:

1. Discuss methods used to train animals for tieing.

2. Ask students to write a short outline of how to train a selected type of animal to be led or as in hogs to be guided.

3. Review parts of the animals hoof and methods of trimming hooves to correct problems. Look at Leg Problems Transparencies in Selection of Meat Animals Lesson.

4. Take a field trip to view the clipping and grooming of different livestock species for a show.

5. Arrange for each student to gain practice in training and preparing a selected livestock species for a show. This could be done by having students each take part during a field trip in grooming and training. Another method would be to arrange with breeder to have students work with some market animals to learn from experience how to fit and show livestock.

6. Have students that have fair projects work with students that do not in gaining experience in learning to fit and show livestock. The progress made could be evaluated by a parent or owner and by the teacher. Pictures of students working in the project could help to record student progress.

SUGGESTED EVALUATION:

1. Give a written test on methods of fitting and showing.

2. Evaluate students activities in preparation of livestock.

3. Provide a quiz on procedures observed during the field trip.

UNIT VII

HORTICULTURE
Introduction to the Unit

This unit is to provide the vocational agribusiness student with a general introduction to the biological concepts and the technology basic to many of the specialized horticultural occupations.

The following information of this unit introduction is provided for aiding the teacher in his presentation of the unit.

LESSONS:

1. Horticulture Careers
2. Horticulture Structures and Equipment
3. Plant Identification
4. Plant Propagation
5. Plant Maintenance
6. Landscape Design
7. Vegetable and Fruit Production

OBJECTIVES:

Upon completion of this unit the student will be able to:

1. Discuss the competencies and requirements needed to enter into the different horticulture fields.
2. Identify commonly used horticultural structures and horticultural equipment.
3. Identify a given group of plants common to the area.
4. Demonstrate the steps involved in plant propagation.
5. Demonstrate the techniques involved with plant maintenance.
6. Discuss the economic and aesthetic value of a landscape design.
7. Identify fruits and vegetables grown by the industry in the area.

MOTIVATION:

Providing horticultural plants for an ever-increasing population is challenging the horticulturist to seek even better technological methods of plant production. To understand just what methods to use to increase plant production requires a basic understanding of horticultural plant production, therefore, we start at the beginning with basics. Ask the students to describe a city without plants, a plantless continent, a plantless world. Discuss the importance of both food-providing plants and aesthetically-pleasing plants.

TEACHING REFERENCES:

A. General References:

1. The Greenhouse Worker, The Ohio Agricultural Education Curriculum Materials Service, 2nd Edition, 1974.
2. The Nursery Worker - Part I, The Ohio Agricultural Education Curriculum Materials Service, 1971.
3. The Garden Center Worker, The Ohio Agricultural Education Curriculum Materials Service, 1971.
4. Landscape Maintenance and Establishment, Penn State University, Vol. 9, No. 25, 1968.
5. Nursery Production, Teacher Education Service, Penn State University, Vol. 12, No. 4+, 1971.
6. The Nursery Worker, Part II, Ohio Agricultural Education Curriculum Service, 1971.
7. Career Preparation in Ornamental Horticulture, A Curriculum Guide for High School Vocational Agriculture, U.S. Department of Health, Education, and Welfare.
8. Identifying Horticultural Crops Manual, Purdue University, Cooperative Extension Service, HO-55.
9. Greenhouse Flowers and Bedding Plants for Agribusiness Studies, The Interstate Printers and Publishers, 1975.
10. Landscaping Your Home, Agricultural Education Service, State Department of Education and Department of Agricultural Education, Ohio State University, 1968.
11. Landscaping Your Home, Revised Edition, University of Illinois, Cooperative Extension Service, Circular III, 1975.
12. Raising Vegetables, the Interstate Printers and Publishers, 1969.
13. 1974 Census of Agriculture, Indiana, U.S. Bureau of the Census.

B. Addresses to General References:

1. The Ohio Agricultural Education Curriculum Materials Service
   Ohio State University
   Columbus, Ohio

2. Teacher Education Series
   Penn State University
   College of Ag riculture
   University Park, Pennsylvania

3. U.S. Department of Health, Education and Welfare
   Ohio State University
   Columbus, Ohio

4. Mailing Room
   Agricultural Administration Building
   Cooperative Extension Service
   Purdue University
   West Lafayette, Indiana

   OR County Extension Office

5. The Interstate Printers and Publishers
   Danville, Illinois

6. Agricultural Cooperative Extension Service
   University of Illinois
   Urbana, Illinois

7. Subscriber's Services Section
   Bureau of the Census
   Washington, D.C.

C. Handouts:

1. "Questionnaire for Prosepctive High School Agribusiness Employers"
2. "Hotbeds and Coldframes, Purdue Universith HO-53
3. "Plant Identification"
4. "Starting Seed Indoors," Purdue University HO-14
5. "New Plants from Cuttings," Purdue University HO-37
6. "Seed Germination Requirements"
7. "Pruning Ornamental Trees and Shrubs", Purdue University HO-4
8. "Soil Sampling for Homeowners," Purdue University HO-71
9. "Ten Steps to a Good Lawn," Purdue University AY-1

10. "Planting Ornamental Trees and Shrubs," Purdue University HO-100
11. "House Plant Care," Purdue University HO-39
12. "Growing Annual Flowers," Purdue University HO-99
13. "How to Control Turf Insects," Purdue University E-61
14. "Insect Pests of the Flower Garden," Purdue University E-70
15. "Vegetable Insect Identification," Purdue University E-67
16. "Some Common Vegetable Diseases," Purdue University BP-13
17. "Landscaping at Home," Purdue University HO-111,112,113
18. "Recommended Vegetable Varieties," Purdue University HO-101

D. Transparency Masters

1. "Horticulture Careers"
2. "Limiting Factors and Requirements for Success"
3. "Greenhouse Structures"
4. "Watering Systems"
5. "Hand Tools"
6. "Leaf Terms for the Hardwoods"
7. "Fertilizer Analysis"
8. "pH Scale"
9. "Safety First"
10. "Methods of Pest Control"
11. "Limiting Factors and Requirements for Seccess"

E. Films Sources:

1. Vernard Films
   Box 1332
   Peoria, Illinois 61601

2. Modern Talking Picture Service
   2323 New Hyde Park Road
   New Hyde Park, New York 11040

3. Farm Film Foundation
   1425 H Street, NW
   Washington, D.C. 20005

4. Department of Horticulture
   Dr. J. A. Wott
   Purdue University
   West Lafayette, Indiana 47907

F. Supply Catalog Sources:

1. Ball Seed Company
   Box 335
   West Chicago, Illinois 60185

2. A. H. Hummert Seed Co.
   2746 Chouteau Avenue
   St. Louis, Missouri 63103

3. A. M. Leonard, Inc.
   6665 Spiker Road
   Pique, Ohio 45356

4. Stuppy Greenhouse Supply
   1212 Clay Street
   North Kansas City, Missouri 64116

5. Gloechner and Co., Inc.
   15 East 26th Street
   New York, New York 10010

LESSON 1: HORTICULTURE CAREERS

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List the skills necessary to be employed in:
    a. The greenhouse industry
    b. The nursery business
    c. The garden center business
    d. The landscaping business
    e. Golf course maintenance
    f. Park service area
    g. Fruit and vegetable production
    h. Horticultural sales
2. Write a short explanation of the employment opportunities in each field.
3. Select a field in horticulture that would be suited to the student's needs.

MOTIVATION:

Many high school students would answer "yes" if asked if they are interested in horticulture. But, in which part of horticulture are they interested? Which part are you, as a teacher interested in? How do they differ? It is important for students to know the complete story of what areas exist in horticulture to allow them to narrow their area of selection.

REFERENCES:

The Greenhouse Worker, The Ohio Agricultural Education Curriculum Materials Service

The Nursery Worker - Part I, The Ohio Agricultural Education Curriculum Materials Service

The Garden Center Worker, The Ohio Agricultural Education Curriculum Materials Service

Landscape Maintenance and Establishment, Penn State University

Film Sources: Vernard Films
Modern Talking Picture Service
Farm Film Foundation
Department of Horticulture, Purdue University

Handouts: "Questionnaire for Prospective High School Agribusiness Employers"

Transparency Masters: "Horticlture Careers"

OUTLINE:

A. Necessary Job Skills of Each Horticulture Business:

1. Greenhouse industry:

   a. The Grower Assistant:
      (1) Under grower's supervisor
      (2) Performs basic jobs in greenhouse
      (3) Technical experience recommended
      (4) Work is sometimes seasonal
   b. The Grower:
      (1) Responsible for work necessary in growing crop
         - Soil preparation
         - Planting
         - Watering
         - Spraying
      (2) Technical experience required
      (3) Several years of work experience also required
   c. The Foreman:
      (1) Responsible for the overall operation of all or part of the greenhouse range
         - Oversees work of growers
         - Plans production schedules
         - Orders supplies
         - Plans spray schedules
      (2) Technical experience required
      (3) Managerial ability required
      (4) Several years of work experience also required
   d. Greenhouse Manager:
      (1) Usually owner, except in larger operations
      (2) Responsible for total greenhouse operation
         - Business management
         - Crop production
         - Greenhouse mechanical systems
         - Sales
      (3) Technical experience required
         - High school
         - College
      (4) Managerial ability required
      (5) Several years of work experience are also required
   e. Other greenhouse job classifications:
      (1) Physical plant manager
         - Responsible for operation and maintenance of the heating plant
         - Responsible for other associated mechanical systems
      (2) Greenhouse technician
         - The greenhouse "trouble-shooter"
         - Responsible for a technical facet of the greenhouse

        Pesticide application
        Soil and foliar analaysis
        Determination of fertilizer application rates
    (3) Plant propagator:
        - Responsible for cuttings
        - Also growing of stock plants
        - Work can be seasonal
    (4) Sales person:
        - Wholesale sales
        - Retail sales
        - Work can be seasonal

2. Nursery Business:

    a. Crew members - (Budding, tree trimming, etc.)
        (1) Most common entry job in a nursery
        (2) Under foreman's supervision
        (3) Technical experience recommended
        (4) Seasonal employment
    b. Foreman: (Propagation, weed control, harvesting, etc.)
        (1) Responsible for one area of the nursery operation
        (2) Technical experience required
        (3) Managerial ability required
        (4) Work experience, a necessity
    c. Nursery Salesman:
        (1) Technical and/or practical experience required
        (2) Sales ability also required
        (3) Employment can be seasonal
    d. Plant breeder:
        (1) Responsible for new varieties of plants
        (2) Technical and/or practical experience required
    e. Mechanic:
        (1) Responsible for maintenance of nursery equipment
        (2) Technical and/or practical experience required
    f. Nursery manager:
        (1) Responsible for total operation of nursery
        (2) Technical experience required
        (3) Managerial ability required
        (4) Work experience is also required

3. The garden center:

    a. Garden center worker:
        (1) Responsible for care of plants at garden center
        (2) Does most of the physical chores at the center
        (3) Technical and/or practical experience is recommended
        (4) Employment can be seasonal
    b. Salesperson:
        (1) Technical and/or practical experience required
        (2) Selling and salesman abilities required
        (3) Employment can be seasonal
    c. Garden center manager:
        (1) Responsible for total operation of garden center
        (2) Technical and/or practical experience required
        (3) Managerial ability required

4. The Landscape Business:

   a. Landscape worker:
      (1) Under supervision of foreman in establishing and maintaining landscapes
      (2) Employment is generally seasonal
      (3) Technical and/or practical experience recommended
   b. Landscape Gardener:
      (1) Responsible for establishing and maintaining landscape
      (2) Technical and/or practical experience required
      (3) Managerial ability is also required
      (4) Employment can be seasonal
   c. Landscape nurseryman:
      (1) Designs, establishes, and maintains small scale landscaping projects
      (2) Also establishes and landscapes from plans developed by landscape architect
      (3) Technical and practical experience are required
      (4) Managerial ability is also necessary
   d. Landscape Designer:
      (1) Designs landscape projects
      (2) Technical experience is required
      (3) Practical experience is also useful

5. Golf course maintenance:

   a. Crew worker:
      (1) Under foreman's supervision
      (2) Performs maintenance duties
          - Mowing
          - Weed control
          - Fertilization
          - Insect and disease control
          - Structure repair
          - Pruning
      (3) Technical and/or practical experience recommended
      (4) Employment is generally seasonal
   b. Foreman:
      (1) Supervises crew members
      (2) Technical and/or practical experience required
      (3) Managerial ability also required
   c. Greenskeeper:
      (1) Supervises foreman and crew workers
      (2) Technical and practical experience required
      (3) Managerial ability also required
   d. Grounds superintendent:
      (1) Supervises greenskeepers, foremen, and their crews
      (2) Technical and practical experience required
      (3) Managerial ability also required

6. The Park Service:

   a. Crew worker:
      (1) Works under supervision of park foreman
      (2) Engaged in maintenance and establishment of nursery plantings, flower beds, walks, drives, and park equipment

        (3) Technical and/or practical experience are recommended
        (4) Seasonal employment
    b. Park foreman:
        (1) Supervises a work crew
        (2) Technical and/or practical experience are required
        (3) Managerial ability required
        (4) Sometimes seasonal employment
    c. Park manager:
        (1) Supervises total park activities
        (2) Technical and/or practical experience required
        (3) Managerial ability required
        (4) Ability to meet and work with people is essential

7. Fruits and vegetables:

    a. Vegetable grower
    b. Vegetable farm hand
    c. Picking crew foreman
    d. Row boss - thinning
    e. Fruit farm foreman
    f. Grove foreman
    g. Berry grower
    h. Grape grower
    i. Orchardist
    j. Fruit farm hand
    k. Fruit-harvester operator
    l. Laborer

8. Sales:

    a. Florist salesman
    b. Landscape salesman
    c. Nursery stock salesman
    d. Horticulture supply salesman
    e. Garden center clerk
    f. Garden center salesman
    g. Wholesale warehouse clerk

TEACHING LEARNING ACTIVITIES:

1. Have class participate in a survey of occupational opportunities in the horticulture business in the local community. The survey would have a two-fold purpose: (1) Identify local career opportunities, and (2) Inform employers in horticulture of potential employees. Supply class with the questionnaire.

2. Invite local horticulture persons into the classroom to help inform the students about the various horticulture placements available.

3. Conduct field trips to local horticulture businesses. Emphasize competencies and requirements needed for employment.

4. Invite the school guidance counselor to explore careers in horticulture with the class.

5. Show horticulture career films to class.

6. Have the students role play job interviews. Before interviewing, have the class develop a list of competencies and requirements for each occupation. Critique each interviewee from this list. A tape recorder is useful here.

SUGGESTED EVALUATION:

1. Instruct each student to write a brief paper using at least two of the horticulture occupations discussed that are of most importance to him. Ask why these occupations interest the student. Ask what job qualifications are necessary. Ask which job qualifications the student possesses.

QUESTIONNAIRE FOR PROSPECTIVE HIGH SCHOOL AGRIBUSINESS EMPLOYERS

1. Name of business ______________________________
2. Address ______________________________
3. Telephone number ______________________________
4. Type of business ______________________________
5. Name of person supplying information ______________________________

   Title ______________________________
6. Number of employees: Full-time ______ Part-time ______
7. Minimum educational requirement acceptable for entry level employment.

   ___ A. Less than high school

   ___ B. High school graduate

   ___ C. High school graduate with special training
8. Does company policies permit you to accept students on a cooperative basis during their high school senior year? ______________
9. Do you feel there is a need for this kind of training program in our area? ______________________________
10. Would you be willing to train our high school seniors in your firm?

    ____
11. Are the trends in employment in your area on the up-swing or in a slump? ______________________________
12. Are there promotional possibilities within your firm? ____________

HORTICULTURE CAREERS

A. GREENHOUSE INDUSTRY:

1. Grower Assistant
2. Grower
3. Foreman
4. Greenhouse Manager
5. Physical Plant Manager
6. Greenhouse Technician
7. Plant Propagator
8. Salesperson

B. NURSERY BUSINESS:

1. Crew Members
2. Foreman
3. Salesperson
4. Plant Breeder
5. Mechanic
6. Nursery Manager

C. GARDEN CENTER:

1. Garden Center Worker
2. Salesperson
3. Garden Center Manager

D. LANDSCAPE BUSINESS:

1. Landscape Gardener
2. Landscape Nurseryman
3. Landscape Designer

E. GOLF COURSE MAINTENANCE:

1. Crew Worker
2. Foreman
3. Greenskeeper
4. Ground Superintendent

F. PARK SERVICE

1. Crew Worker
2. Foreman
3. Park Manager

LESSON 2: HORTICULTURE STRUCTURES AND EQUIPMENT

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write the names of greenhouse structures when shown pictures, diagrams, or examples of the structures.
2. Identify and list horticulture hand and power tools from diagrams, examples, and pictures.
3. Identify the names of specialized horticulture equipment.

MOTIVATION:

It would be impossible to speak a language without knowing the meaning of the words. It would also be impossible to talk about horticulture without knowing the meanings of some of the horticulture terms. What is a hot bed, a head house, a mist system, or a quonset greenhouse?

REFERENCES:

The Greenhouse Worker, Ohio Agricultural Education Curriculum Service

Nursery Production, Penn State University

The Nursery Worker, Part II, Ohio Agricultural Education Curriculum Service

Career Preparation in Ornamental Horticulture, A Curriculum Guide for High School Vocational Agriculture, U.S. Department of Health, Education and Welfare

Horticulture Supply Catalogs

Handouts: "Hotbeds and Cold Frames", Purdue University, HO-53

Transparency Masters: "Glass Solitary House"
"Greenhouse Structures"
"Watering Systems"
"Hand Tools"

OUTLINE:

A. Horticulture Structures:

1. The greenhouse industry:

a. Types of greenhouses used:
   (1) Quonset greenhouses. Half circle design, simple and easy to construct, covered with plastic-type covering and economical. Disadvantages: Low side walls and must be recovered every one or two years.
   (2) Even-span solitary house. The two sides of the roof are equal in width and pitch. A permanent structure. Covered (glazed) with polyethylene, vinyl, polyvinylchloride (PVC), polyvinyl flouride, plexiglass, fiberglass, or glass. Substancial initial expense.
   (3) Ridge and furrow greenhouse. Even span, but it consists of houses built side by side connected by the gutter. Cheaper to construct than solitary even-span house. Disadvantages: Attached houses cast shade upon the next house, maintenance of separate temperatures in each house is difficult, and spread of insects and diseases is harder to control. Snow load can be a problem from build up in the furrows.
   (4) "Van Wingerden" house. Similar to ridge and furrow, but with a double poly covering. They are less expensive to built and can save up to 40% in fuel costs. The two layers of poly have air between them (3-4 inches) for insulation. Disadvantages: Poly must be replaced every one to two years.

2. The nursery business:

   a. Types of structures used:
      (1) Greenhouses. Same types used in the greenhouse industry.
      (2) Cold frames. Shelter used for winter protection of plants. Unheated. Covered with glass or plastic to allow the sun rays inside the frame.
      (3) Hotbed. A heated cold frame.
      (4) Outdoor beds. An outside planting area usually covered with snow fencing for protection.
      (5) Lath house. Snow fencing or wooden strips supported on a framework 7-8 feet over the plants. Used for protection from sun, wind and heavy rain; to maintain temperature; and to prevent rapid evaporation of water from plants.
      (6) Saran house. Similar to lath house, but covered with a nylon netting rather than laths. Gives same protection.
      (7) Cloth house. Similar to Saran house, but the openings in the cloth are smaller which prevents insects and some diseases from entering. Disadvantage: tears easily.

3. The garden center:

   a. Types of structures used:
      (1) Greenhouses
      (2) Outdoor beds
      (3) Lath houses
      (4) Saran houses
      (5) Sales rooms

4. The landscape business:

   a. Types of structures used:
      (1) Greenhouses
      (2) Outdoor beds
      (3) Holding areas
      (4) Lath houses
      (5) Saran houses
      (6) Sales rooms

B. Horticulture Hand and Power Tools:

1. Common horticulture hand tools:

   a. Shovels - round point, square nose, long handle, short handle
   b. Spades - tree digging, shrub digging, etc.
   c. Spading forks - usually have four tines, short handled
   d. Hoes - various shapes and sizes used
   e. Cultivators - various number of prongs
   f. Pitch forks and rakes
   g. Various knives - budding, pruning, grafting, etc.
   h. Shears and pruners - various sizes and shapes
   i. Garden trowels - different sizes
   j. Respirators and goggles

2. Common horticulture power tools:

   a. Tractor - medium size, 30 to 40 hp, utility type. Hydraulic system necessary for implements
   b. Garden tiller - various sizes
   c. Lawn care equipment
   d. Common power tools - drills, saws, sanders, etc.

3. Specialized horticulture equipment:

   a. Watering systems:
      (1) Hand watering breakers
      (2) Mist system
      (3) Capillary water mats

   b. Soil sanitizers:

      (1) With chemicals
      (2) With steam
   c. Plant benches:
      (1) Elevated benches
      (2) Ground beds
   d. Head houses:
      (1) Work areas for potting, transplanting, etc.
      (2) Located on north side of greenhouse.
   e. Lighting systems:
      (1) Florescent light
      (2) Incandescent light
      (3) HID lamps

f. Sprayers:
   (1) Hand-held sprayers
   (2) Motorized sprayers
   (3) Tractor-mounted sprayers
   (4) Respirators, goggles, rubber gloves, coat, cap and boots

TEACHING LEARNING ACTIVITIES:

1. Show students the item being discussed by the use of a visual aid if the actual item cannot be shown.
   a. Show students different structures used in horticulture. Explain the special situation in which each is used. Use visual aids and a field trip to assist the discussion of structures.
   b. Have students make a list of equipment that would be used. Discuss the lists with the class and make additions or corrections. Show examples of the equipment.
   c. Have students collect catalogs showing horticultural equipment and/or supply catalogs to the class from horticulture businesses.

2. Conduct a field trip to a horticulture business to observe the structures and equipment discussed or to be discussed.

3. Prepare and hand out a mimeograph copy of the items to be discussed.

4. Obtain horticulture catalogs from horticulture businesses. Use these catalogs as teaching aids to show equipment and plants. Check unit references for catalog sources.

SUGGESTED EVALUATION:

1. Use illustrations or actual equipment and have students identify each piece of equipment by name and use in the horticultural industry.

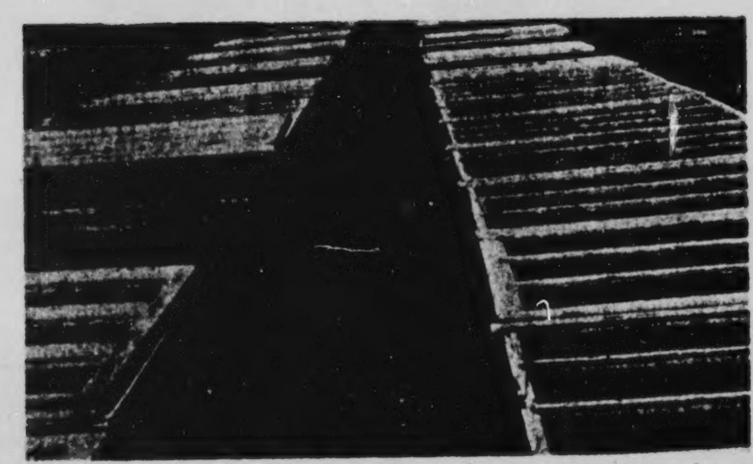
2. Construct a matching test with names of various kinds of hardware commonly used with horticultural equipment in one column and have students match with another column which lists the use of the hardware.

3. Show students various pieces of horticultural equipment and have them list the safety precautions or procedures to be followed to operate the equipment safely.

HO-53

building and using

HOTBEDS & COLD FRAMES



Hotbeds and cold frames get plants started early.

Cooperative Extension Service
Purdue University
West Lafayette, Indiana

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The hotbed, cold frame, and other plant growing structures are used for the growing of plants out of the normal season. Commercial and home gardeners find it to their advantage to have well-grown, stocky plants ready to set in the garden just as soon as the weather will permit transplanting.

The transplants have a 3 to 4 weeks' start over the direct seeding operations in the field. Earliness is an important factor in the production and harvesting of vegetables that thrive best under the cool, moist conditions of early summer. The commercial gardener finds prevailing prices very good for this early produce and the home gardener is just as anxious to be one of the first to supply the table with the products of his own handiwork.

The transplants of cabbage, cauliflower, lettuce, and other early season plants are tolerant to cool weather and when "hardened off" they may be set in garden soil at least by early April.

The hotbed differs from the cold frame in that the soil and air are warmed by artificial heat. The cold frame depends on heat from the sun. Construction of the framework should be the same—sturdy, tight, and covered with glass sash. The standard size sash is 6 feet long and 3 feet wide, although some plant growers use the "melon sash" which is 10 feet long and 4 feet wide.

Glass substitutes are valued proportionally to the amount of sunlight which they admit and the stability of the material. Cloth covers are flimsy and generally most unsatisfactory. The bed may be as long as the gardener finds convenient, using multiples of either 3 or 4 feet width of sash. A standard two-sash bed, 6 x 6 feet, will produce a great number of plants.

Where Should Bed Be Located?

The plant bed should be placed where it will be well protected from the wind, on a well-drained spot, near a good supply of water, and a source of heat. It should be in an open area to take full advantage of the sunshine during the day.

Construct from Wood or Concrete

The same construction is used for making both a cold frame and hotbed. A small cold frame that will supply plants for the home gardener may be built as a lean-to against the house and a frame covered with storm sash or a similar type of window.

The framework of the bed can be constructed from wood or concrete. When wood is used, the boards may be one, or preferably 2 inches thick. The front of the bed, to the south, should be 10 to 12 inches, inside measurement, with 2 inches extending below ground level. The back portion should be 6 inches higher than the front, having a slope of one inch per foot. Beds made from concrete should extend into the soil 6 to 8 inches and the wall should be at least 3 inches in thickness. The bed should be true for a snug fit. The soil on the outside should be banked around the frame to conserve the heat.

Pit Hotbed (Figure 1). When manure or other fermenting materials are used to supply the heat, the soil inside the bed should be excavated to a depth of 16 to 18 inches. A 4-inch layer of coarse cinders or gravel forms the bottom portion for drainage and improving the aeration of the bed. Fill the bed with manure; then tamp firmly and evenly, especially in the corners. The tamped manure should extend an inch or so above the ground level on the inside of the frame. Moisten the manure evenly with lukeworm water to insure uniform heating.

Cover the manure with 3 or 4 inches of good, weed-free garden soil. Soil that is fairly warm when put in the bed permits earlier heating and consequently early seeding.

When the bed is ready, fit the sash over the bed and place two or three accurate thermometers, extending 2 to 3 inches into the soil in representative places to check on the heat. When the soil temperature drops to 75° or slightly less, the bed is ready for seeding.

Electric Hotbed (Figure 2). Electric heating utilizes an insulated heating cable enclosed in a flexible lead sheath covering. It will require about 60 feet of cable for a bed 6 x 6 feet with a 110-volt outlet. Excavate the

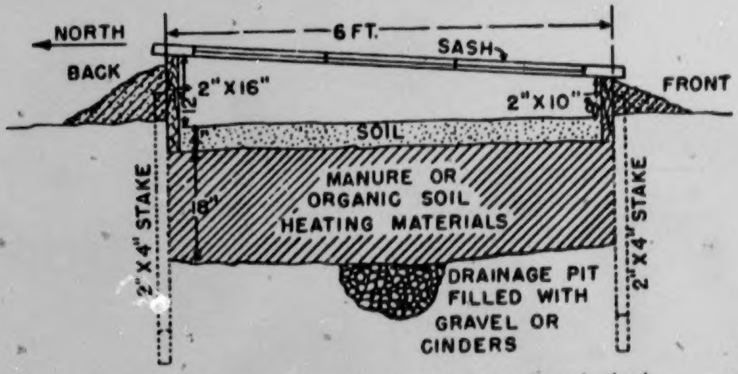

NORTH
BACK
6 FT.
SASH
FRONT
2"X16"
2"X10"
SOIL
18"
MANURE OR ORGANIC SOIL HEATING MATERIALS
DRAINAGE PIT FILLED WITH GRAVEL OR CINDERS
2"X4" STAKE
2"X4" STAKE

Figure 1. Cross section of a manure-heated pit hotbed.

Figure 2. Arrangement of cable and thermostat in an electric hotbed.

soil 2 or 3 inches below the frame level. Then put down 4 inches of cinders or sand as a base for the cable.

When you lay the cable start and end with the outside row 3 inches away from the frame and make a series of long 6-inch loops across the bed. The cable, when attached to a thermostat, automatically controls the temperature in the bed. A 3- to 4-inch layer of good planting soil, or sand when used for sweet potatoes and melons, should then be put over the cable.

Consult your local electric company for details.

Flue-Heated Hotbed (Figure 3). The use of dry heat, furnace firing, is a very satisfactory and economical way to heat a hotbed—several fuels, such as oil or coal, can be used. The heat passes through heat-conducting pipes, generally 4-inch tile, from the furnace to a 6- to 8-inch flue or chimney on the outside of the bed at the opposite end.

When constructing the flue-heated bed, it's best to start with the fire box. A pit 3 feet square and 6 feet deep, inside dimensions, will serve as the furnace room. A steel drum will make a good stove when laid on the side with a door at the bottom of one end and two outlets at the top of the opposite end. The outlet end of the drum should be 3 to 4 feet away from the front end of the bed.

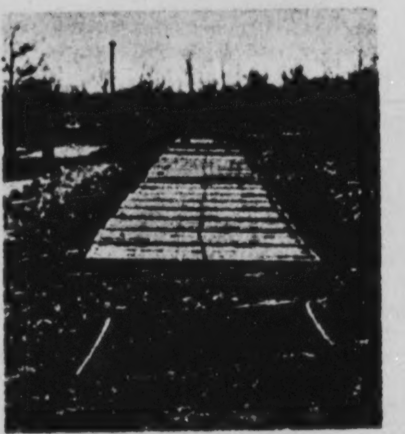


Figure 3. Flue-heated beds carry the heat from the firebox pit (foregroun under the plants to the exits at the fa end of the frame.

Connect two lines of heat-conducting pipes to the furnace and lay them about 18 inches from each side of the bed, slanted upwards to about 6 inches from the surface at the far end.

The frame of the bed, preferably concrete, should be built around the tile and the pipes covered with cinders or clean sand. A bed 6 feet wide and 40 to 50 feet in length is a good size. Use sand for the growing of sweet potato plants or for a base for flats or melon boxes, and three inches of soil for direct seeding.

The fire should be started as soon as the sashes are in place and three to four days ahead of seeding or bedding time. Generally one night and one day firing will supply enough heat to keep the bed warm except during cold weather.

Steam- and Hot Water-Heated Hotbed. The use of steam or hot water circulating systems is practical when the beds are supplementary to a greenhouse operation. The heating pipes may be placed under the soil or around the inside edge and near the top of the frame. The heat is turned on or off as needed. Gardeners will find steam heat requires more attention at night than other means of heating the bed.

Make Plant Growing Easy

The soil or manure that you use in the hotbed or cold frame for plant growing should be the best you can find. Many weed seeds, insects, and diseases are found in just ordinary soil. Use fumigants and other soil sterilization principles to keep troubles out of the bed. When fumigants are used, either for the soil or for the manures used in the plant boxes or flats, the materials should be thoroughly aired before seeding. The use of commercial fertilizers in the plant bed is not recommended.

The heat in the bed will determine, in part, when the seed should be sown. Generally 30 to 40 days will be required from seeding time to transplanting time. The seed may be sown directly in the soil or in plant boxes, such as veneer bands, peat pots, clay flower pots, or in flats. Four-inch veneer plant boxes or pots are the best size for field transplants. As a rule 50 to 100 seeds are sown per foot of row in rows 6 to 8 inches apart when the young plants receive a double transplanting.

When you use boxes or pots, press two seeds into the manure

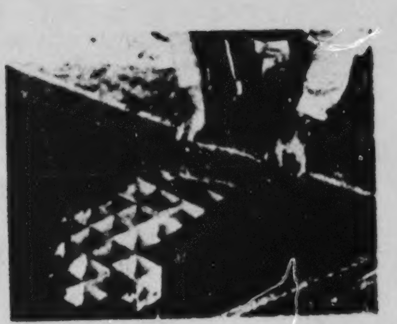


Figure 4. Start melons in individual boxes.

or soil-filled container. Later thin to one plant. After planting the seed spread a light covering of sand over the surface. When you "bed" sweet potatoes, space the roots an inch or so apart, and cover with 2 to 3 inches of good clean sand.

The use of shredded cow manure in the plant boxes provides the best media for growing melon and tomato plants. Place the containers in the bed *(Figure 4)* and cover with finely cut manure. Firmly and evenly tamp the manure up to the top of each plant box.

The temperature of the bed should be from 70° to 75° until the young plants are about one inch high. Then lower the temperature to 65° during the day and 55° to 60° for the night, except for sweet potato plants. Growing the plants cool produces better plants and as a rule results in earlier setting of the fruit, particularly for tomatoes, melons, and peppers.

A straw mat, roofing paper *(Figure 5)* or tarpaulin should be readily available to cover the cold frame when cold weather threatens to cause freezing temperatures. A 100-watt lamp left burning during the cool nights will aid in keeping the bed warm. The plant growth is slower in the cold frame than in the hotbed.

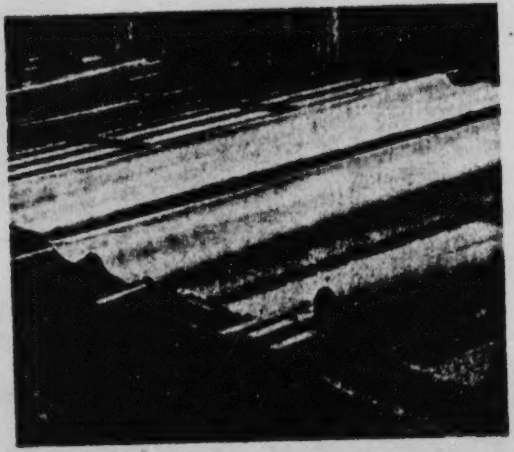


Figure 5. Covers protect hotbeds and cold frames on extremely cold nights.

Carefully Regulate Watering and Ventilation

Plants grown with a limited amount of water and with controlled temperatures are the best ones. Apply water, preferably warm, during the morning when the sun is shining. Overwatering and high temperatures encourage troubles from diseases, or bring on spindly, sappy growth.

Proper ventilation of hotbeds and cold frames not only controls temperature, but also aids in preventing damping-off disease.

When ventilating the bed, raise the sash opposite the direction of the wind *(Figure 6)*. As the season advances leave the sash off during the greater part of the day and eventually leave it off entirely—first all day, then all day and all night—to "harden off" the plants.

The plants in the bed should be protected at all times from pests, especially insects, by the timely application of a good combination fungicide and insecticide. A spraying or dusting of the plants just before field planting will give more protection against the pests in the field. Transplanting, even when carefully done, is somewhat of a shock to the plant and the use of a pint of starter solution around the root system will settle the soil and aid in rapid adjustment to field conditions. When veneer plant bands are used for melons, the discarded shell should be left in the furrow and covered by the first cultivation.

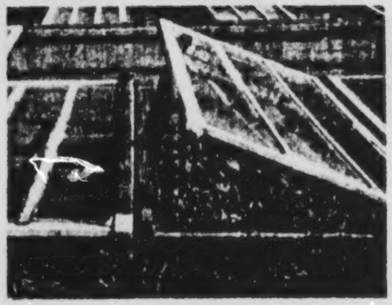


Figure 6. Both hotbeds and cold frames should have adequate ventilation.

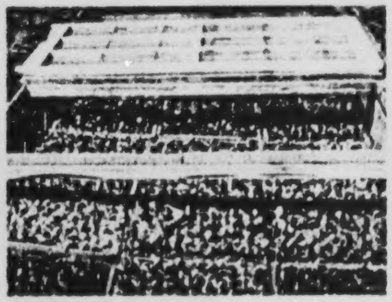


Figure 7. "Harden off" plants before planting them in the field.

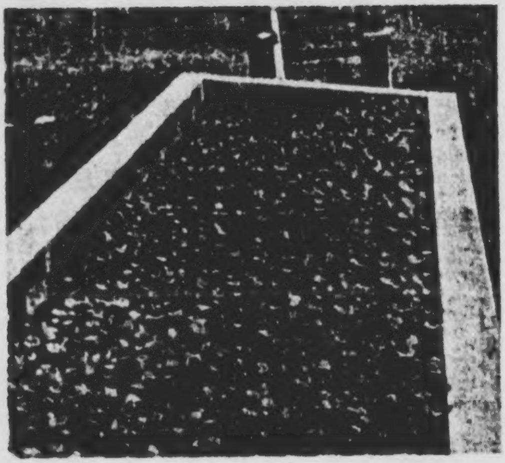


Figure 8. Melon plants, seed sown in April, are ready for transplanting in the field by May 1.

Related Publications

Contact your local County Extension Office or Agricultural Publications, Purdue University, Lafayette, Indiana 47907.

Home Horticulture

HO-14, *Starting Seeds Indoors*
HO-26, *Growing Tomatoes*
HO-28, *Growing Herbs*
HO-29, *Growing Salad Vegetables*
HO-32, *Home Gardener's Guide to Tasty Fruits and Vegetables*
HO-33, *Selecting Vegetables for Your Garden*
HO-61, *Growing Perennial Flowers*
HO-99, *Growing Annual Flowers*

Commercial Horticulture

EC 493, *Tomato Production in Plastic Greenhouses*

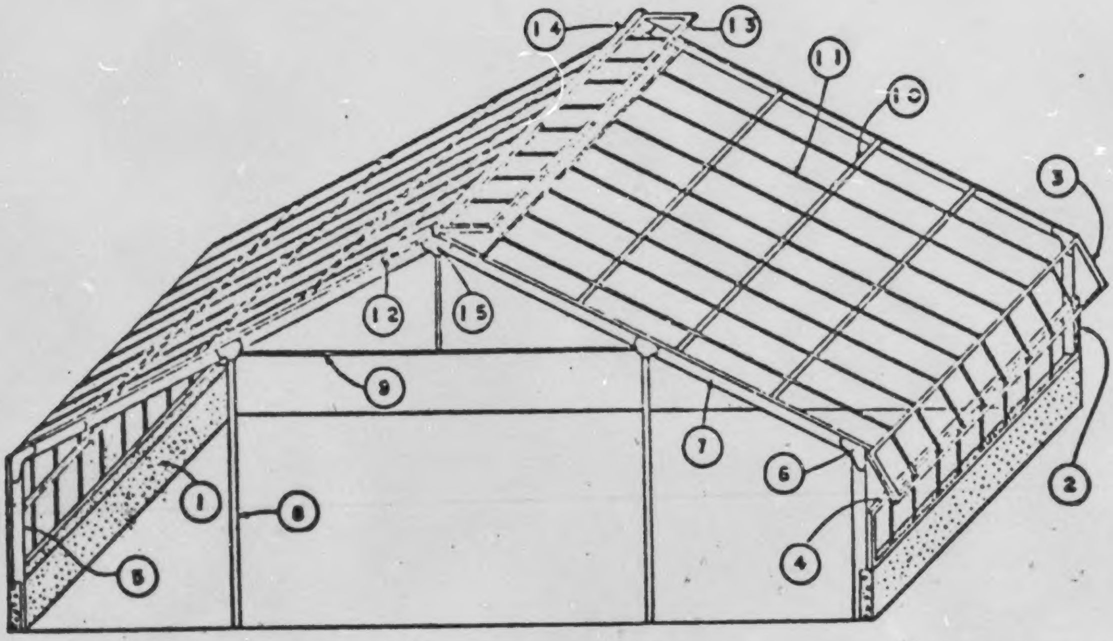
HO-61-1, *Bibb and Leaf Lettuce in Plastic Greenhouses*

HO-62-1, *Horticultural Plant Production in Plastic Greenhouses*

ID-56, *Indiana Vegetable Production Recommendations for Commercial Growers*

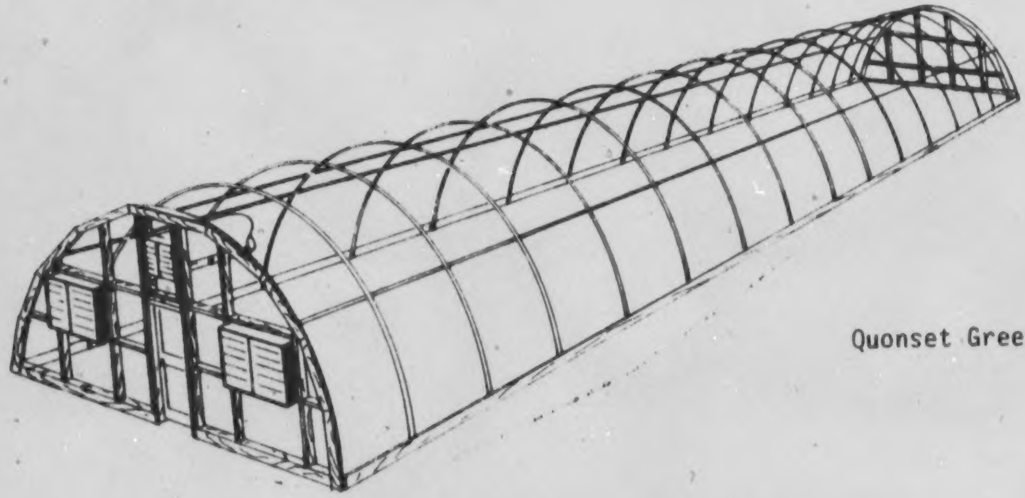
Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

GLASS SOLITARY HOUSE

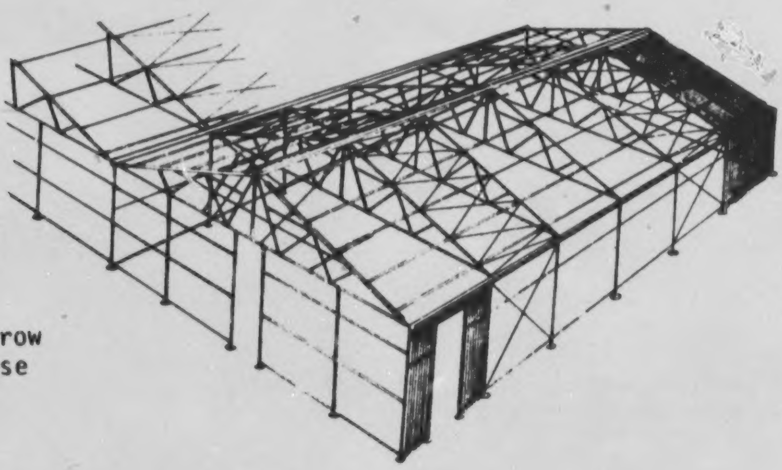


1. sidewall or curtain wall	6. splice plate or gusset	11. sash bar
2. lower side sash	7. rafter	12. ridge vent header
3. side ventilator	8. column	13. ridge vent
4. transom sill	9. cross tie	14. ridge and ridge cap
5. side post	10. purlin	15. ridge plate

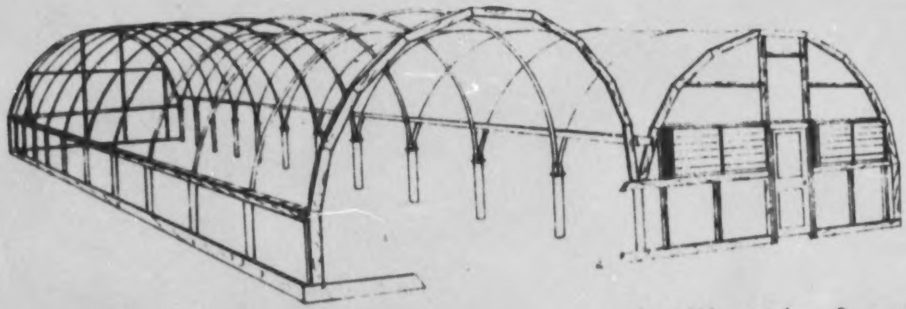
GREENHOUSE STRUCTURES



Quonset Greenhouse

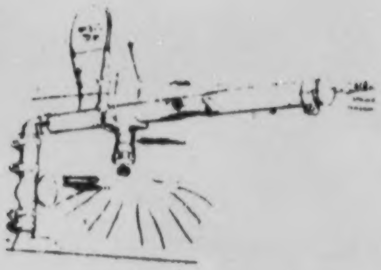


Ridge & Furrow
Greenhouse

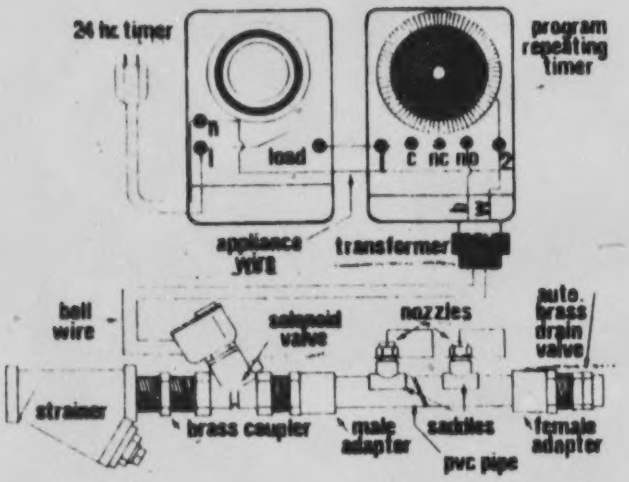


Van Wingerden Greenhouse

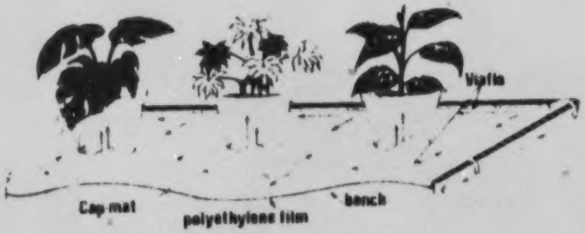
WATERING SYSTEMS



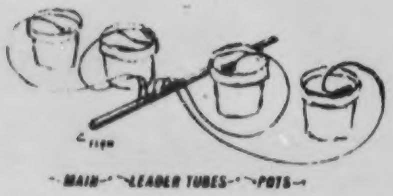
Mist Nozzle


24 hr. timer
program repeating timer
n
l
load
c
nc
no
2
appliance wire
transformer
bell wire
solenoid valve
nozzles
auto. brass drain valve
strainer
brass coupler
male adapter
saddles
pvc pipe
female adapter

Mist System
(automatic)

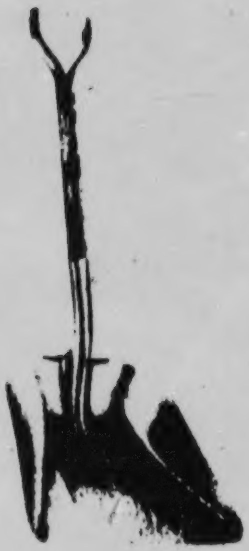

Vialls
Cap mat
polyethylene film
bench

Cappilary Watering Pads


← from
MAIN
LEADER TUBES
POTS

Spaghetti System

HAND TOOLS



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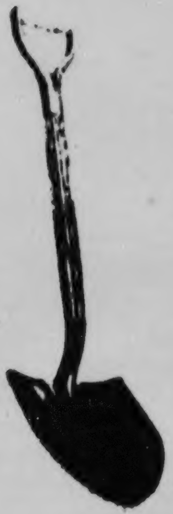

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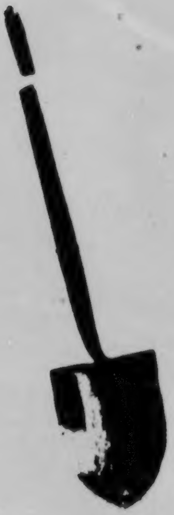

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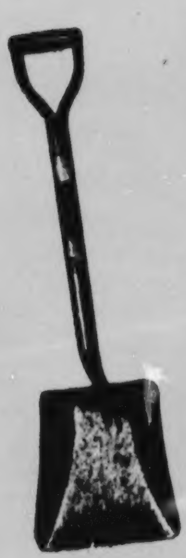

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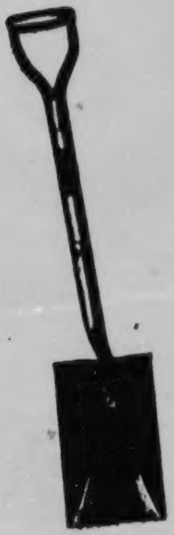

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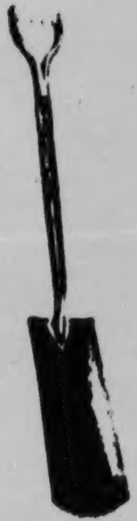

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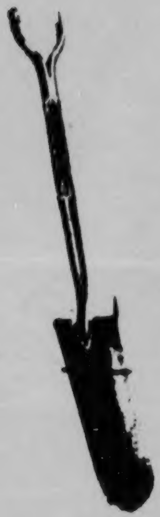

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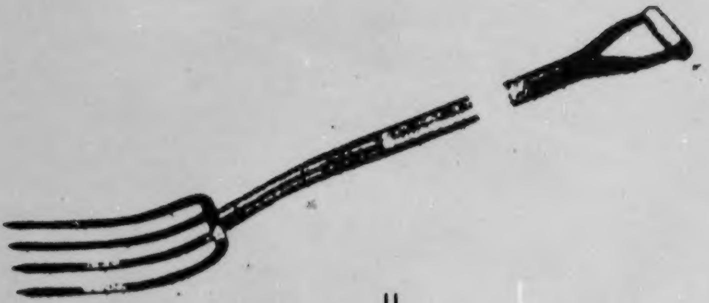
HAND TOOLS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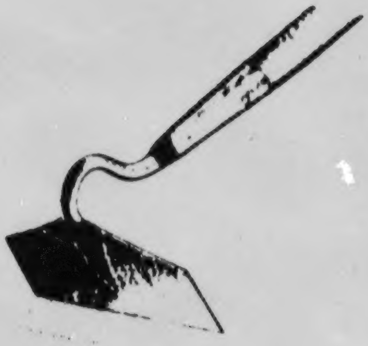
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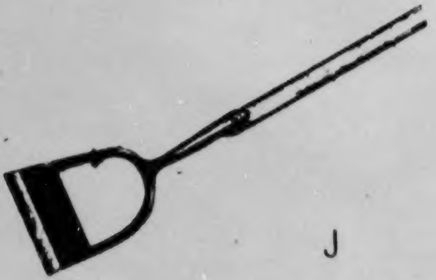
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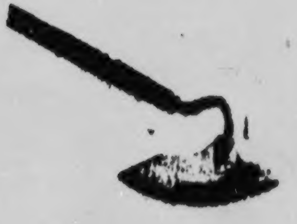
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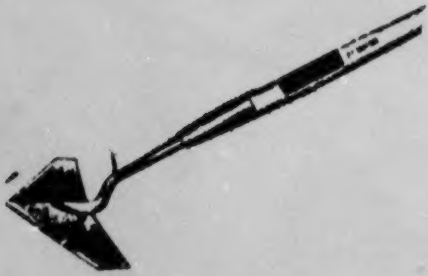
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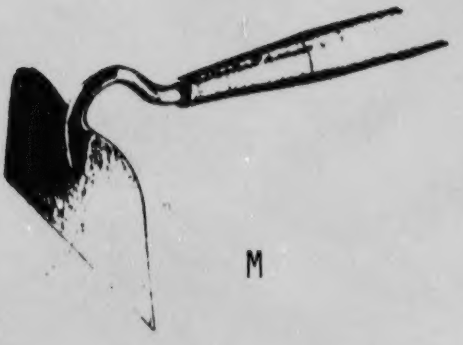
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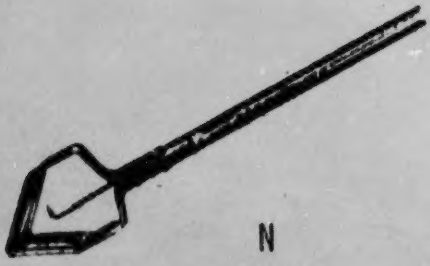
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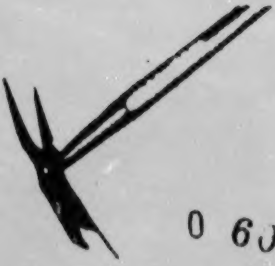
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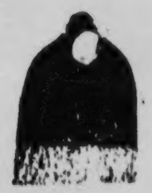
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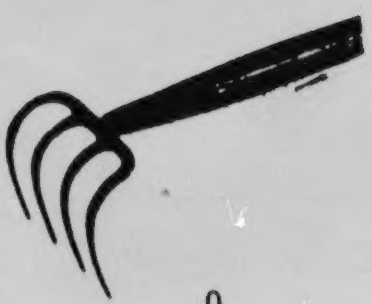
HAND TOOLS



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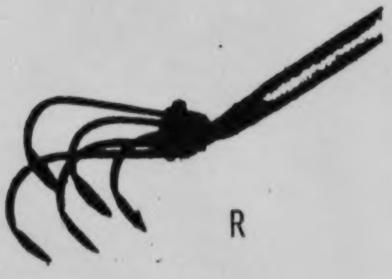

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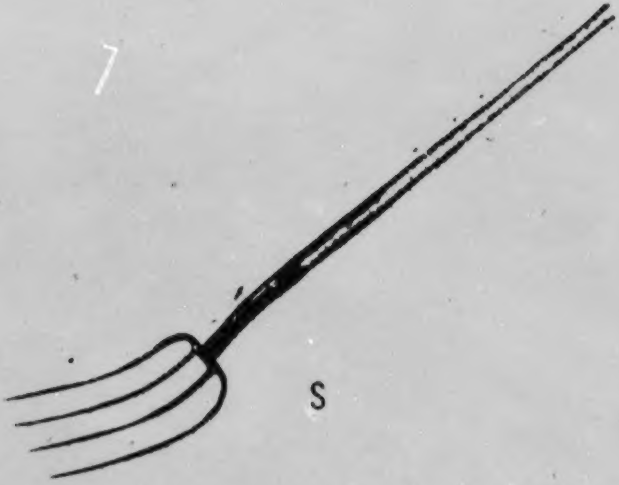

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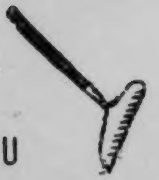

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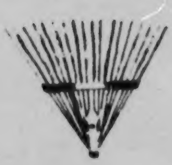

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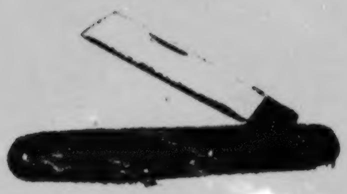
HAND TOOLS



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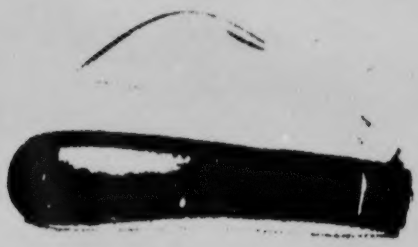

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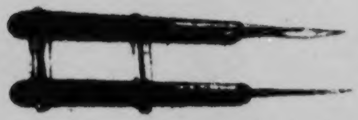

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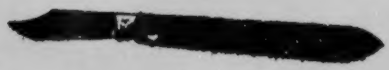

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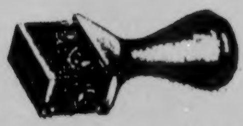

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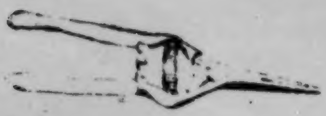

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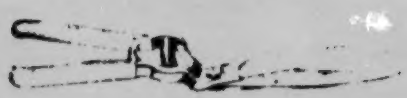

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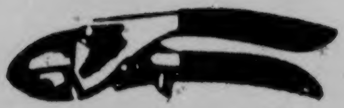
HAND TOOLS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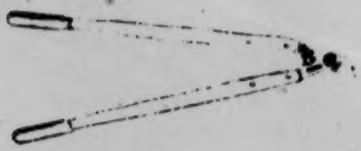
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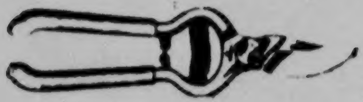
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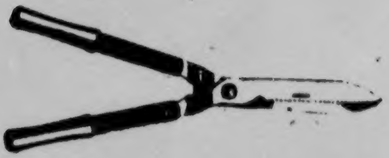
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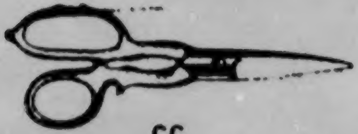
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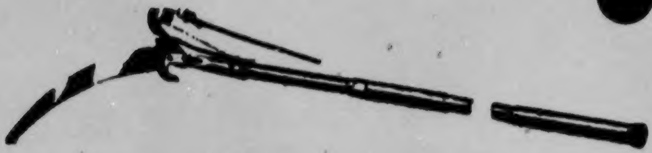
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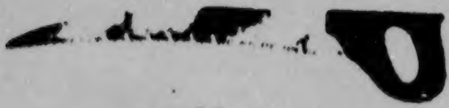
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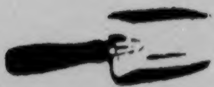
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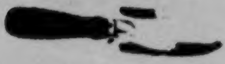
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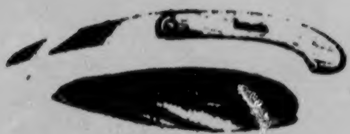
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HAND TOOLS

A. SCOOP SHOVEL
B. ROUND POINT SHOVEL
C. SPADING SHOVEL
D. ROUND POINT SHOVEL
E. GARDEN SPADE
F. BALLING AND ROOT PRUNING SPADE
G. TRANSPLANTING OR DRAIN SPADE
H. SPADING FORK
I. NURSERYMEN'S HOE
J. DUTCH SCUFFLE HOE
K. CAVEX HOE
L. SCUFFLE HOE
M. GARDEN HOE
N. PUSH HOE
O. WEEDING HOE
P. GRUB HOE
Q. FOUR TINE CULTIVATOR
R. CULTIVATOR
S. PITCH FORK
T. LAWN RAKE
U. GARDEN RAKE
V. GRAFTING KNIFE
W. CAMILLUS PRUNING KNIFE
X. BUDDING KNIVES
Y. BUDDGING KNIFE
Z. PATCH BUDDER
AA. FLORIST SHEARS
BB. GRASS SHEARS
CC. ANVIL PRUNER
DD. HOPPER
EE. HAND PRUNER
FF. HEDGE SHEARS
GG. UTILITY SHEARS
HH. TELESCOPING TREE PRUNER
II. PRUNING SAW
JJ. UTILITY TROWEL
KK. TRANSPLANTING TROWEL
LL. PRUNING SAW (FOLDING SAW)

LESSON 3: PLANT IDENTIFICATION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Identify ten common deciduous shrubs from pictures and samples.
2. Identify ten common evergreen shrubs from pictures and samples.
3. Identify ten common deciduous trees from pictures and samples.
4. Identify ten common evergreen trees from pictures and samples.
5. Identify ten common houseplants from pictures and samples.

MOTIVATION:

You can't enjoy the game until you learn to identify the players. Horticulturists need to be able to identify the common plants used in their area. It is satisfying and in many jobs in horticulture, it is a necessity. Can you think of some people in horticulture whose jobs depend on their ability to identify plants?

REFERENCES:

Career Preparation in Ornamental Horticulture, A Curriculum Guide for High School Vocational Agriculture, U.S. Department of Health, Education and Welfare

The Garden Center Worker, The Ohio Agricultural Education Curriculum Materials Services

Identifying Horticultural Crops Manual, Purdue University, HO-55

Trees, Shrubs, and Vines, Syracuse University Press.

Handout: "Plant Identification"

Transparencies: "Leaf Terms for the Hardwoods"

OUTLINE:

A. General Types of Plants:

   1. Deciduous shrubs. A woody perennial plant of low stature, characterized by persistent stems and branches springing from the base. It loses its leaves annually (in the fall) and goes into a dormant state (in the winter). It is rejuvenated in the spring.

   - a. Forsythia
   - b. Spirea

2. Deciduous trees. A larger woody perennial plant characterized by single stem and branches springing from that central stem. Also lose leaves and go dormant.
   - a. Dogwood
   - b. Maple

3. Evergreen shrubs. Shrubs that stay green year round.
   - a. Needle-leaf
     - (1) Yews
     - (2) Junipers
   - b. Broadleaf
     - (1) Viburnums, evergreen
     - (2) Azaleas, evergreen

4. Evergreen trees. Trees that stay green year round.
   - a. Needle-leaf
     - (1) Pines
     - (2) Firs
   - b. Broadleaf
     - (1) Hollies
     - (2) Magnolias

5. Houseplants:
   - a. Foliage - indoor plants used for their distinctive leaves
     - (1) Palms
     - (2) Philodendrons
   - b. Flowering - indoor plants used for their distinctive flowers
     - (1) Geraniums
     - (2) Mums

B. Plant Names:

1. Scientific names: tell the genus and species of the plant, such as the English Pea - Pisum sativum.

2. Common names: usual nomemclature used to identify the plant, such as Pisum sativum - English Pea.

C. Identification Characteristics:

1. Evergreen or deciduous?

2. Indoor plant or outdoor plant?

3. Size of plant?

4. Leaf description:
    a. Arrangement = opposite or alternate
    b. Composition = simple or compound
    c. Margin = lobed or not lobed
5. Outstanding characteristics?

TEACHING LEARNING ACTIVITIES:

1. Obtain samples of leaves or plans that the students are to be able to identify. These can be obtained at nurseries, greenhouses, garden centers, parks, homes or home yards. Have students use plant keys extension bulletins, or horticulture sales catalogs to identify the chosen plants, press the leaves between cardboard pieces to flatten then mount them with contact paper. On the lower left hand side of the paper, list the following information for each leaf specimen:

    Scientific Name
    Common Name
    Description of Leaves
    Distinguishing Characteristics
    Plant Use

2. Press leaf samples by using contact paper on white poster board. Have students make leaf impression by using a large rubber stamp pad to make leaf images. If available, use a photocopier to make leaf and twig impressions. When collecting leaves have students get a twig sample indicating the leaf arrangement.
3. Take a walking field trip for the purpose of plant identification without the use of the plant key, catalogs or bulletins.
4. Use a premapped guide to plants in the school area for identification. Tape comments on a cassette tape and check out tapes and recorders to students that go on tour. Make this an optional class assignment allowing self-study of plants.
5. Invite a knowledgeable resource person to discuss plant identification methods with the class. Resource people used might include some other teacher, county agent, or a local horticulture worker.
6. Provide students worksheets that would contain information about the designated plants.
7. Set up a matching exercise using pictures, slides, or other visual aids and have students match visuals with a list of the assigned plants.
8. Have students bring in various plant leaves to identify by using identification aids.
9. Take a field trip to a horticulture business to observe a variety of plants. These plants will probably be name-tagged, therefore, it's a good learning situation.

10. Each day at the beginning of class, introduce a number of new plants and quiz the students on identification of those plants at the end of period. Use Identifying Horticultural Crops Manual for aid in plant identification.

SUGGESTED EVALUATION:

1. Set up a matching exercise using plants, pictures, slides, or other visual aids and have students match with a list of plants that have been discussed.
2. Have students fill in data on selected plants using the plant ID sheet. Evaluate students from these sheets.

PLANT IDENTIFICATION
WORK SHEET

No. ________

1. Name (common) ____________________ (scientific) ________________
2. Uses ____
3. Mature size (spread) ________________ (height) ________________
4. Color (flowers) ____________________ (foliage) Spring ____________
Summer ____________
(fruit) ____________________ Fall ____________
5. Growth rate ____
6. Exposure preferred ____
7. Special features shape ________________ soil ____________________
foliage ________________ flower ____________________

No. ________

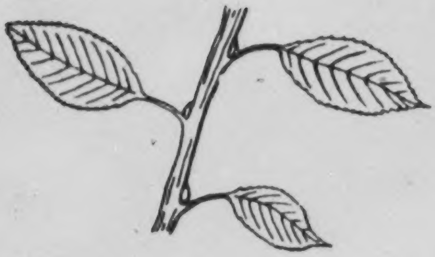
1. Name (common) ____________________ (scientific) ________________
2. Uses ____
3. Mature size (spread) ________________ (height) ________________
4. Color (flowers) ____________________ (foliage) Spring ____________
Summer ____________
(fruit) ____________________ Fall ____________
5. Growth rate ____
6. Exposure preferred ____
7. Special features shape ________________ soil ____________________
foliage ________________ flower ____________________

No. ________

1. Name (common) ____________________ (scientific) ________________
2. Uses ____
3. Mature size (spread) ________________ (height) ________________
4. Color (flowers) ____________________ (foliage) Spring ____________
Summer ____________
(fruit) ____________________ Fall ____________
5. Growth rate ____
6. Exposure preferred ____
7. Special features shape ________________ soil ____________________
foliage ________________ flower ____________________

LEAF TERMS FOR THE HARDWOODS

LEAF ARRANGEMENT (Branching)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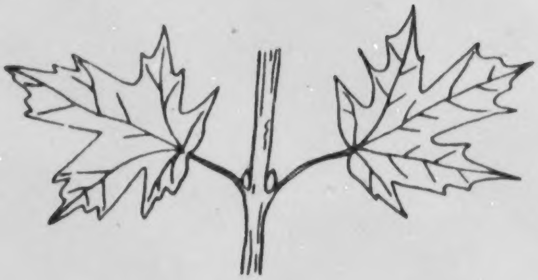
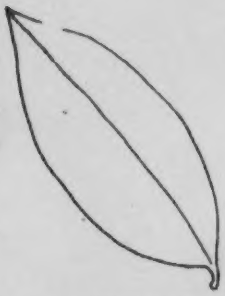

Opposite

SIMPLE LEAVES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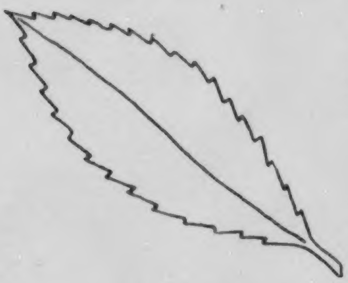
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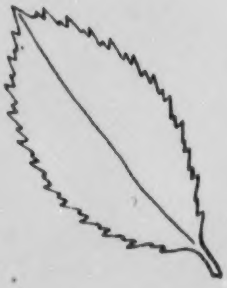
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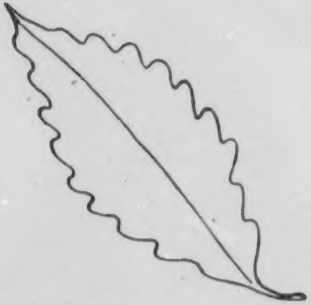
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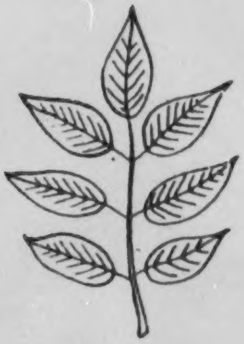
COMPOUND LEAVES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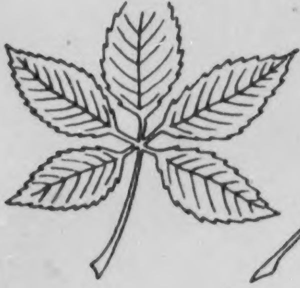
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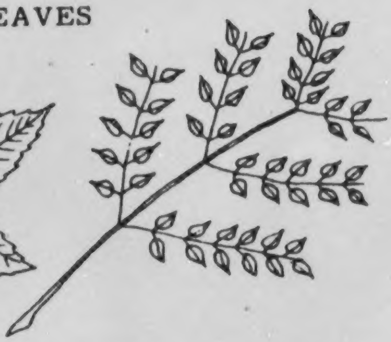
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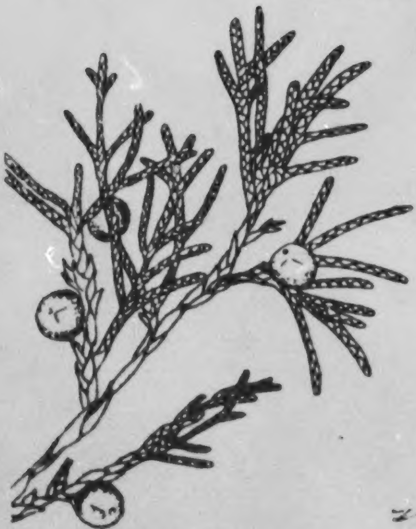
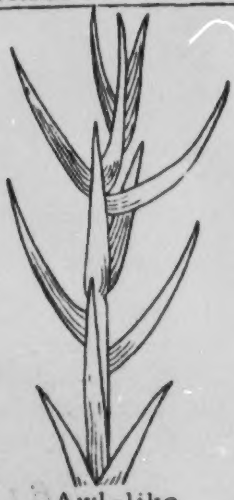
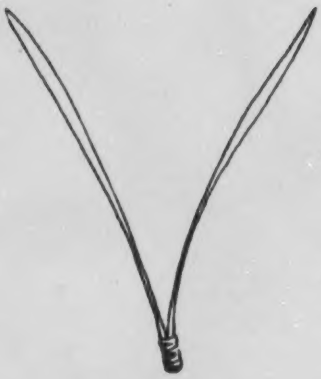
LEAF FORMS OF THE CONIFERS


Scale-like

Holmes


Awl-like

614


Needle-like

LESSON 4: PLANT PROPAGATION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Prepare a germination or rooting medium.
2. Sow seed to recommended specifications.
3. Raise seedlings to the transplanting stage.
4. Propogate and transplant rooted cuttings.

MOTIVATION:

Many plants can be reproduced from vegetative parts. If plants are propagated from seed, two parents are required (a male and female). If plants are vegetatively propagated (without seed) only one parent is involved. Which plants are reproduced by seed? Which are reproduced asexually (vegetatively)?

REFERENCES:

Career Preparation in Ornamental Horticulture, A Curriculum Guide for High School Vocational Agriculture, U.S. Department of Health, Education and Welfare.

The Greenhouse Worker, the Ohio Agricultural Education Curriculum Materials Services.

Greenhouse Flowers and Bedding Plants for Agribusiness Studies, The Interstate Publishers.

Nursery Production, The Penn State University, College of Agriculture.

The Nursery Worker, Part II Nursery Practices, Department of Agricultural Education, Ohio State University.

Handouts: "Starting Seed Indoors," Purdue University, HO-14
"New Plants From Cuttings," Purdue University, HO-37
"Seed Germination Requirements"

OUTLINE:

A. Sexual Propagation: Reproduction by Seed

1. Define seed. Living organisms consisting of an embryo (tiny plant), a reserved food supply, and a seed coat or covering.

2. Define seed germination. Sprouting of seed.

3. Seed germination requirements:

   a. Moisture necessary for germination:
      (1) Softens seed coat so that water and O_2 enters, respiration increases, CO_2 exits
      (2) Embryo swells
      (3) Seed coat opens (cracks or splits)
      (4) New plant emerges with leaf, stem, and roots

   b. Temperature (warmth) necessary for germination:
      (1) Most favorable temperature range will vary with the species
         - Few seeds will germinate under 50° F
         - From 60° to 75° F is favorable for most plants
      (2) Soil temperatures should be constant - Some seeds actually prefer alternating temperatures.

   c. Air necessary for seed germination:
      (1) Oxygen is essential
      (2) The germinating media should be permeable to air as well as water:
         - If the medium is too wet, the air is excluded
         - If the seed is planted too deeply, the air is not available to the seed. General rule for planting depth = 3 times diameter of seed

   d. Light necessary for germination (in some cases)
      (1) Important to the germination of some species
      (2) Other species germinate better in total darkness
      (3) Light is essential after the seedling emerges from the soil for photosynthesis to occur

   e. Seed viability necessary for germination:
      (1) Definition. Refers to the seed's ability to develop into a new plant under favorable germinating conditions
      (2) Seed viability factors:
         - The age of the seed
         - The method of storage
      (3) Pre-germination treatments:
         - Scarification methods - weakening seed coat
            By cutting seed coat with knife
            By using acids to weaken seed coat
            By soaking seeds in water
         - Stratification or moist-chilling
      (4) Seed tag information helpful:
         - States the seed purity - weed seeds, foreign materials, etc. present in the seed package
         - States the germination rate of the seed - _____%

B. Asexual Propagation - Vegetative Reproduction:

1. Define cutting. A vegetative plant portion removed (from the plant) for propagation. One method of asexual propagation.

2. Rooting requirements for cuttings:

   a. Moisture necessary for rooting:
      (1) Moist but not water-logged
      (2) New roots must never be allowed to dry out
   b. Temperature (warmth) necessary for rooting:
      (1) Most favorable temperature range will vary with the species
      (2) Rooting medium temperature can be constant (10° F higher than air temperature) for some hard-to-root species
   c. Air necessary for rooting:
      (1) Oxygen and carbon dioxide are essential
      (2) The rooting media should be permeable to air as well as water
   d. Light necessary for rooting (Photosynthesis):
      (1) Essential for formation of new roots
      (2) Helps to produce food for new root formation:
         - Photosynthesis produces food in leaves
         - Food is translocated to new roots
         - New roots develop

3. Types of cuttings:

   a. Leaf cutting - using whole leaves or parts of leaves to produce a new plant
   b. Root cutting - using root sections to produce a new plant
   c. Stem cutting - using stem and/or leaf-stem sections to produce a new plant

4. Types of rooting media:

   a. Medium grade sand
   b. Peat - generally too wet
   c. Sand and peat mixture (1:1)
   d. Perlite
   e. Vermiculite
   f. Perlite or Vermiculite and sand mixture (1:1)
   g. Perlite and Vermiculite and sand mixture (1:1:1)
   h. Perlite and Vermiculite (1:1)

5. Root-inducing compounds - Rootone, Hormex, etc.

   a. Speed rooting of cuttings
   b. Increases size and number of roots
   c. Insures a higher percentage of rooted cuttings

TEACHING LEARNING ACTIVITIES:

1. Discuss sexual and asexual propagation with the class using the outline information to aid in discussion.
2. Teacher will demonstrate seed sowing procedures and techniques used for optimum germination using available facilities.
3. Students will sow fine seeds and larger seeds and accurately label the planting container with student's name, name of plant, date, and other pertinent information.
4. Students are to record the date of germination, decide date of hardening (toughening) of plant, and then decide date of transplant to new container.
5. Teacher will demonstrate correct procedures for making and sticking cuttings of available plants, using available facilities.
6. Students are then assigned a number of cuttings of certain kinds of plants to propagate using different types of cuttings.
7. Students are to record information such as date of making cuttings, date of first roots, and date of transplanting cuttings.
8. Students are to blend media in different proportions and note the water holding capacity of each after 1/2 hour, after 24 hours.
9. Students are to try to germinate seed in a refrigerator with a temperature below 50° F. Also try to root cuttings in a refrigerator.
10. Students are to root cuttings while using root-inducing compounds and also to try rooting cuttings without the root-inducing compounds.
11. Students are to record and compare data on each. Data should include: (1) Time of rooting; (2) Size and number of roots; (3) Percent of rooted cuttings.
12. Have students examine effect of number of leaves per cutting on rooting.
13. Allow students to germinate corn and bean seeds. Draw and label cross-section through seed and later draw and label seedling.

SUGGESTED EVALUATION:

1. Each student should demonstrate or list the steps in the seeding operations. This would include: (1) Seedbed preparation; (2) Seeding, and (3) Maintaining suitable growing conditions.
2. Each student should correctly demonstrate or describe the procedure for asexually propagating plants by (1) Leaf cutting; (2) Root cutting, and (3) Stem cutting.
3. Data sheets on seeding and cuttings should be evaluated.

YARD & GARDEN
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HO-14
1977

STARTING SEEDS INDOORS

John A. Wott
Extension home environment horticulturist

Starting garden flowers and vegetable plants indoors from seed is fun. The largest advantage to starting them yourself is that you'll have the varieties of plants you want, when you want them.

What and when to plant

The accompanying table suggests when to plant seed indoors and when to transplant common annual flowers and vegetables. Dates are given for central Indiana. Plant 20 days earlier in southwestern Indiana and 10 days later in northeastern Indiana.

Plants	Start indoors	Transplant outdoors
Annuals		
Ageratum	March 15	May 15
Alyssum	March 1	April 15
Aster	April 1	May 15
Marigold	April 1	May 15
Petunia	March 15	May 15
Salvia	April 1	May 15
Snapdragon	March 1	May 15
Zinnia	April 15	May 15
Vegetables		
*Cabbage	March 1	April 15
Celery	March 1	May 15
Cucumber	April 15	May 15
Eggplant	March 1	April 1
Lettuce (leaf)	March 1	April 1
Melon	April 15	May 15
Pepper	March 15	May 15
Squash	April 15	May 15
Tomato	April 1	May 15

*Cabbage can usually be planted outdoors early in the spring. However, exposure to cold spring temperatures often will cause the plants to "bolt."

How to plant

A soil mixture for starting seeds should be loose, well-drained, fine-textured, and low in nutrients. Usually a mixture of equal parts garden soil, sphagnum peat moss, and sand is desirable. Be sure to screen the mixture to remove lumps, rocks, and other debris.

To guard against seedling diseases such as damping-off, the soil and sand in your mixture should be sterilized in an oven. Fill a container with moist — but not wet — soil, and bake. The soil should reached a temperature of at least 180° for 30 minutes. To achieve this, you may want to turn the oven slightly higher. Some homeowners also place a raw potato in the center of the soil and bake with a medium oven until the potato is done. Be prepared for a strong odor from the baking soil mixture.

Caution After the soil is sterilized, any disease organisms introduced will multiply much more rapidly than before. To avoid introducing damping-off organisms through your planting containers, use presterilized fiber seed flats or peat pots. If you use wooden boxes, clay flower pots, or metal pans, clean them well and then sterilize them along with the soil mixture. Also clean and sterilize your planting utensils. A solution of one part chlorine bleach to 10 parts water can be used as a rinse.

Fill the planting container with the soil mixture to 1 inch from the top, and firm. Thoroughly water the tamped medium. Then add ½ inch of vermiculite, sand, or sphagnum peat moss.

Available commercially are expandable and ready-made individual pots already containing soil mixes. Also available are soil preparations containing peat, vermiculite or perlite. Homeowners should weigh the economics of using their own preparations with the ease and convenience of a pre-packaged planting operation.

Follow planting directions on the seed packet. In flats, make the rows 2 inches apart. For large seeds, make the depression no deeper than ½ inch. With small seed such as petunia, almost no covering is needed. Large-seed vegetables such as cucumber, melon and squash can be planted in peat pots or expandable pots filled with the soil mixture — two seeds per pot.

After sowing, water with a fine mist. Label each container and cover it with polyethylene plastic film (a vegetable bag will do), or a piece of window glass. Labels should be written in pencil and contain the name of plant, date of sowing, and color of flowers. Water only often enough to keep the soil moist. Most seeds start best at 60-75°F. Be careful not to place the plastic-covered containers in direct sunlight, as the heat buildup under plastic can kill emerging seedlings.

Once the seed has sprouted, take off the polyethylene film or glass and put the containers in a sunny window or under flourescent light. If possible, grow plants at 50 to 60°F. The new seedlings will need both water and fertilizer. Do both at once by using a solution made by mixing 1 tablespoon of soluble fertilizer in 1 gallon of water. Water the seedlings thoroughly, but carefully, so as not to wash them out of the container.

Transferring seedlings

After the two juvenile leaves have developed (usually about two weeks after sowing), transfer each seedling into an individual peat pot or larger flat with a similiar sterilized soil mixture.

To transfer, carefully dig up the small plants with a large knife or spatula. Let the group of seedlings fall apart and pick out individual plants. Poke a hole in the soil mixture and set the seedlings ½ inch apart in flats. For seeds sown in individual pots, thin to one seedling per pot, if both seeds have germinated. Be extra careful not to pinch the tender seedling. Firm the soil, and water gently. Shade the plants for a few days or replace under fluorescent lights, where there is little heat buildup. Continue watering and fertilizing.

Plant care

Most annual flowers respond to pinching, which encourages side branching. Usually the top inch or two is removed from the growing tip, leaving 3 or 4 leaves. **Don't pinch vegetable plants.**

You may want to reduce watering to "harden" the seedlings. This makes them less tender and more tolerant of outside growing conditions.

Transplanting outdoors

Add 1-2 pounds of 5-10-5 or a similar analysis fertlizier per 100 square feet of garden area before you prepare the soil. Then prepare the area 6-8 inches deep by spading, rototilling or plowing.

Transplant your seedlings outdoors at the recommended date, weather permitting. To transplant, dig a hole roughly twice as large and twice as deep as the soil ball around the roots of your transplants. Then set the plants only slightly deeper than they grew before. Place soil loosely around the roots, and add 1 cup of starter solution. This solution is made by dissolving one tablespoonful of water-soluble high phosphate fertilizer (10-52-17 or similar analysis) in one gallon of water.

Plants grown in fiber, plastic or clay pots should be removed from their containers before planting. Plants grown in peat pots can be transplated intact, but you may wish to remove the bottom portion to improve drainage. If plants grown in peat pots are to be planted in extremely sandy soil, the entire pot should be removed. The pots act like a wick, evaporating moisture from the soil mixture quickly and thus the seedling may wilt and, possibly, die.

If the 2 or 3 days following your transplanting are sunny with high temperatures, cover the plants with newspaper "tents" to prevent wilting. Water as necessary.

Related Publications

Contact your county Extension office or Mailing Room, Agricultural Administration Building, Purdue University, West Lafayette, Indiana 47907, for the following publications.

HO-6	Planting the Vegetable Garden
HO-61	Growing Perennial Flowers
HO-69	Growing Annual Flowers
HO-101	Recommended Vegetable Varieties
HO-26	Growing Tomatoes

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SEED GERMINATION REQUIREMENTS

MOISTURE **WARMTH** **AIR** **VIABLE SEED** **SOMETIMES LIGHT**

LESSON 5: PLANT MAINTENANCE

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Prune or pinch designated plants using demonstrated techniques.
2. Water indoor and outdoor plants.
3. Take a soil sample.
4. Analyze a soil sample and make fertilizer and pH recommendations for meeting requirements of plants.
5. Discuss methods of pest control.
6. List methods of weather protection.

MOTIVATION:

The responsibility of owning a new plant can be compared to that of owning a new car. After you have bought a new car you must follow some type of maintenance schedule or the car won't last long. The same is true concerning plants. Plants must be on some type of maintenance schedule or they won't last long. How do the two maintenance schedules differ?

REFERENCES:

Nursery Production, Penn State University

Greenhouse Flowers and Bedding Plants for Agribusiness Studies, The Interstate Publishers

Career Preparation in Ornamental Horticulture, A Curriculum Guide to High School Vocational Agriculture, U.S. Department of Health, Education and Welfare

The Nursery Worker - Part II, Nursery Practice, The Ohio Agricultural Education Curriculum Materials Service

Landscape Maintenance and Establishment, Penn State University

Handouts: "Pruning Ornamental Trees and Shrubs", Purdue University HO-4
"Soil Sampling For Homeowners", Purdue University HO-71
"Ten Steps to a Good Lawn", Purdue University AY-1
"Planting Ornamental Trees and Shrubs", Purdue University HO-100
"House Plant Care", Purdue University HO-39
"Growing Annual Flowers", Purdue University HO-99
"How to Control Turf Insects", Purdue University E-61
"Insect Pests of the Flower Garden", Purdue University E-70
"Vegetable Insect Identification", Purdue University, E-67
"Some Common Vegetable Diseases", Purdue University BP-13

Transparency Masters: "Fertilizer Analysis"
"pH Scale"
"Safety First"
"Methods of Pest Control"

OUTLINE:

A. Pruning or Pinching: Removing Branches to Improve Plant:

1. Reasons to prune or pinch plants:
    a. To remove or repair injured parts
    b. To stimulate old or overgrown plants (rejuvenation)
    c. To improve shape
    d. To maintain a formal shape
    e. To induce a "fullness" in the plant's growth by removing the terminal or apical bud

B. Watering:

1. Containered plants:
    a. General rule to follow - water when top inch of medium is dry and water until water leaks from the drainage holes in bottom of container
    b. Frequency of watering - depends upon a number of factors including the size and type of the container, humidity, temperature, type of medium, etc.

2. Field plants:
    a. General rule to follow - water newly planted stock about one inch of water per week if it doesn't rain. One inch of water will soak into the soil 6" to 8".
    b. Establish plants - remove spadeful of soil, check deepest point for moisture, if dry, then water with one inch of water.

C. Fertilizing:

1. Contained plants:

   a. Soil test necessary:
      (1) Use soil test kits
      (2) Send to land-grant university (Purdue University)
      (3) Have checked by local horticulture business
   b. The amount of each major element is expressed in "parts per million" (ppm). Desirable ppm's:
      (1) Nitrate - between 15-50 ppm
      (2) Phosphate - from 3-5 ppm
      (3) Potash - between 20 and 40 ppm
      (4) Soil acidity - from 6.0-6.5
   c. Fertilizer forms used:
      (1) Liquid
      (2) Solid
      (3) Gas

2. Field plants:

   a. Soil test also essential
   b. Fertilizer applied in pounds per 100 or 1000 square feet in mass planting or lawns (example: 20-10-10)
      (1) Most shrub planting - 2 1/2 to 3 pounds/1000 square feet
      (2) Individual shrubs - 1/4 to 1/2 pound/plant depending on plant size
      (3) Trees - more fertilizer for deciduous than narrow-leaved evergreens
         - Trees with less than 3-inch diameter at a height of four feet above the ground = 2 to 3 pounds of fertilizer per inch of diameter
         - More than 3" diameter = 4 to 5 pounds of fertilizer per inch of tree diameter
      (4) Lawns:
         - Fertilizer frequency depends upon the type of grass but generally fertilize three to four times annually
         - Use from 2-6 pounds of any of the following: 24-4-12, 19-5-9, 30-3-10, 32-5-3, or any fertilizer that would be in the ration of 4-1-2 at a max. of 3-4 lbs. of N annually.

D. Pest Control (Insect, Disease, and Weed Control):

1. Insects:

   a. Types according to the damage they inflict upon the plant:
      (1) Chewers; i.e., caterpillars, cutworms, etc.
      (2) Suckers, i.e., Aphids, spider mites, etc.
      (3) Leaf miners, i.e., Leaf mining insects
      (4) Borers, i.e., Bark borers, wood borers, etc.
      (5) Root-infesting, i.e., Mole crickets, grubs, etc.
      (6) Gall-forming, i.e., Gall wasps, plant lice, etc.

2. Diseases:

   a. Causitive agents:
      (1) Fungi
      (2) Bacteria
      (3) Viruses

3. Weeds:

   a. Compete with desirable vegetation:
      (1) For light
      (2) For nutrients
      (3) For water
   b. Are unsightly
   c. May be poisonous
   d. Can be a host for insects and diseases

4. Methods of pest control:

   a. Natural control (resistant varieties and adverse weather)
   b. Mechanical control (by hand or machine)
      (1) Pulling weeds
      (2) Killing insects by hand
      (3) Pruning diseased branches
   c. Quarantine (restricting the spread of the pest)
      (1) Locally
      (2) State-wide
      (3) Nationally
   d. Biological control (one organism killing another)
      (1) Praying mantis
      (2) Lady Beetle
      (3) Disease spray used to kill weeds and insects
   e. Chemical control (applying toxic chemicals)
      (1) Insecticides - a chemical used to kill an insect
      (2) Fungicide - a chemical used to kill a disease organism
      (3) Herbicide - a chemical used to kill an unwanted plant (weed)
      (4) Follow recommended safety precautions

E. Weather Protection (Adverse Conditions):

1. Indoor plants:

   a. Keep out of drafts
   b. Keep in recommended foot candles of sunlight

2. Outdoor plants:

   a. Use windbreakers on windward side of fields
   b. Use mulches for protection
   c. Use enclosed structures--cold frames, greenhouses, etc.
   d. Plant sensitive plants on north and northeast of building.

TEACHING LEARNING ACTIVITIES:

1. Demonstrate pinching of plants and have students pinch some commonly pinched plants.
2. Demonstrate pruning of plants and have students prune some commonly pruned plants.
3. Have students experiment with plants by limiting essentials for growth, i.e., light, water, fertilizer, etc.
4. Have students experiment with plants by using excessive amounts of the essentials for growth, i.e., light, water, fertilizer, etc.
5. Have students set up experiments using sand as the growing media and using different levels of the primary fertilizer nutrients: N, P, K
6. Demonstrate and then allow students to run soil tests on greenhouse and field soils.
7. Show examples of the different kinds of fertilizer forms, i.e., granular, liquid, and gas.
8. Discuss transparency, "Methods of Pest Control."
9. Conduct a field trip to a local horticultural business to observe pest control techniques.
10. Have students prepare a plant pest collection.
11. Show the pests or illustrations of the plant pests discussed.
12. Show examples of pesticide labels or illustrations of labels discussed.
13. Have students design an example of a pesticide label.
14. Show and demonstrate pesticide safety equipment.
15. Discuss pesticide safety with class.
16. Show students commonly used weather protection methods.
17. Use the Identifying Horticultural Crops Manual to identify common plant pests in the local area.

SUGGESTED EVALUATION:

1. Evaluate students from the experimental data collected about the essentials for plant growth. Also from the soil test analysis data.
2. Construct a matching test and have students match names of insects, diseases, and weeds with the actual pest or with visual aids.

3. Each student should list and explain the safety precautions to be followed when applying chemicals. The list should include: (1) Reading label directions, (2) Wearing protective clothing, (3) Use of application equipment.

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HO-4

PRUNING ORNAMENTAL TREES AND SHRUBS

by Philip Carpenter and John A. Wott, Extension Horticulturists

Correct pruning is one of the most essential of all maintenance practices for trees and shrubs of the home landscape. Proper pruning will help keep trees and shrubs vigorous, maintain them in proper shape and form for a desirable landscape effect, and add years to their usefulness. Trees and shrubs should be examined on an annual basis with some pruning carried out each year. Too often pruning is ignored for several years. Then many shrubs and trees become overgrown, sometimes weak, and drastic pruning is necessary to reduce the size of the plant, possibly causing permanent damage. Yearly pruning will help keep the plant in bounds and keep its growth vigorous.

Why

Pruning is necessary to maintain a healthy vigorous tree or shrub within a desired size. To achieve this, pruning is carried out for the following reasons:

1. **To maintain or reduce the size of a tree or shrub.** This prevents overgrowing of the landscape plants and eliminates the necessity of trying to rejuvenate large, overgrown specimens. Some plants should be thinned as weak, overcrowded branches develop. Newly-planted trees and shrubs often need pruning to reduce the leaf area to insure establishment and survival of the plant.

2. **To remove dead, diseased and/or broken branches.** This will aid in maintaining the shape, vigor, and health of the plant.

3. **To stimulate future flower and fruit development.** Many flowering plants such as rhododendrons and azaleas will produce more flower buds the following season if old, faded flowers and fruit clusters are removed.

4. **To rejuvenate old shrubs and restore them to new vigor.** Certain shrubs, when overgrown, can be restored to a young natural growth habit by the proper use of rejuvenation pruning. Lilac, privet, forsythia, and some spirea fall into this class of plants.

5. **To prevent damage to life and property.** Overhanging limbs can be hazardous to homes, power lines, nearby plants, and humans.

6. **To shape plants in an unnatural form.** Plants used for screens, i.e. hedges or formal plants, are pruned or sheared to shapes other than their natural growth habit.

THEREFORE, BEFORE STARTING TO PRUNE, UNDERSTAND WHAT IS TO BE ACCOMPLISHED.

When

Knowing when to prune is the most important single factor in the pruning operation. To insure proper response of the plant to pruning, the flowering-fruiting habit of that plant must be known.

1. **Trees and shrubs that flower before the end of June should be cut back or pruned immediately after flowering.** Flower buds have developed during the previous season's growth. Thus, the flowers for this year's bloom were developing last summer, and overwintered in a very small form as a bud. If pruned before flowering in the spring, all of the flower buds would be removed, thus eliminating flowers for this season. Examples of the early flowering plants are shown in Table 1.

2. **Trees or shrubs that flower after the end of June should be pruned in the winter or spring before the new growth starts.** These plants develop their flower buds during the spring growth of the season of flower. Examples are shown in Table 2.

3. **Certain trees and shrubs may be lightly pruned both before and after flowering.** This often increases the bloom and fruit production, and several may also produce a second bloom during the year. Examples are shown in Table 3.

Table 1. **Spring flowering trees and shrubs which should be pruned after flowering.**

Scientific name	Common name
Amelanchier	Shadblow
Azalea	Azalea
Berberis	Barberry
Calycanthus	Sweetshrub
Carangana	Peashrub
Celastrus orbiculatus	Bittersweet
Cersis	Redbud
Chaenomeles	Flowering quince
Cotinus coggygria	Smoketree
Cornus florida	Flowering dogwood
Cornus kousa	Kousa dogwood
Cornus mas	Cornelian cherry
Crategus	Hawthorn
Deutzia	Deutzia
Forsythia	Forsythia
Kalmia latifolia	Mountain laurel
Kolkwitzia amabilis	Beautybush
Ligustrum	Privet
Lonicera	Honeysuckle
Magnolia	Magnolia
Malus	Crabapple
Philadelphus	Mock orange
Pieris	Andromeda
Pyracantha	Firethorn
Prunus	Flowering cherry and plum
Rhododendron	Rhododendron
Rhodotypus scandens	Black jetbead
Rosa	Climbers and shrub roses
Sorbus	Mountain ash
Spiraea thunbergii	Thunberg spirea
Spiraea vanhouttei	Vanhoutte spirea
Styrax japonica	Japanese snowball
Syringa	Common, Chinese, and French lilacs
Viburnum burkwoodii	Burkwood Viburnum
Viburnum carlesii	Korean spice Viburnum
Viburnum lantana	Wayfaring tree
Viburnum opulus	European cranberrybush
Viburnum plicatum tomentosum	Doublefile Viburnum

4. **Shrubs or trees that are prized for their fruit should be pruned after the fruit drops.** Examples are certain viburnums, European mountain ash, and hawthorn. They may flower early in the season but the fruit must be allowed to develop. After the fruit has lost its appeal, pruning may be carried out.

5. **Evergreens, both broadleafed and narrowleafed types, may be pruned anytime the wood is not frozen.** Evergreens may be pruned for Christmas decorations with no danger of injury to the plant. The new shoots of a coniferous (narrowleaf) tree should be pruned back annually if you want a compact plant, or have to control its size. Narrowleafed evergreens will not develop new shoots on the older wood, so don't cut beyond the living foliage portion of the branches.

6. **Some deciduous trees, known as "bleeders" due to the heavy flow of sap in the early pring, may be pruned in the summer or fall.** This is satisfactory if sap dripping from wounds is objectionable falling on the sidewalk, parded automobiles, or on the house. The loss of sap due to pruning will not injure the tree, and fall pruning should be carried out only if the dripping sap is objectionable. Trees that fall into this category are maple, birch, dogwood, elm, walnut, and yellowwood

7. **Avoid late summer pruning in August through mid-September.** Pruning at this time of the year encourages new growth to develop which will not harden sufficiently for the winter, thereby increasing the danger of winter damage.

Table 2. **Summer flowering trees and shrubs which should be pruned before spring growth begins**

Scientific name	Common name
Acanthopanax	Aralia
Abelia grandiflora	Glossy Abelia
Albizia	Silk tree
Buddleia	Butterflybush
Callicarpa	Beautyberry
Clematis	Clematis
Hibiscus syriacus	Shrub-althea
Hydrangea paniculata 'Grandiflora'	P.G. Hydrangea
Hydrangea quercifolia	Oakleaf Hydrangea
Koelreuteria paniculata	Goldenrain tree
Rosa	Hybrid tea

Table 3. **Trees and shrubs which may be pruned both before and after bloom.**

Scientific name	Common name
Cornus stolonifera	Red Osier dogwood
Cotoneaster apiculata	Cranberry cotoneaster
Cotoneaster divaricata	Spreading cotoneaster
Cotoneaster multiflora	Multiflora cotoneaster
Mahonia aquifolium	Oregon hollygrape
Spiraea bumalda	Anthony Waterer and Frobel spirea
Symphoricarpos albus	Snowberry
Symphoricarpos chenaulti	Chenault coralberry
Weigela florida	Rose Weigela

How

Use the proper tools. Tools should be of high quality and sharp. The essential pruning tools are shown in Illustration 1.

Hand shears usually come in sizes 6-to 9-inches long. These are used for cutting branches up to ¼-inch in diameter.

Loppers usually are 20 to 36 inches in length and are used for cuts up to 1-inch in diameter. These shears provide good leverage so cuts can be made on large wood stems.

Hedge shears with 6- to 12-inch blades are used to shear formal hedges. They should not be used to cut large branches and are incorrectly used if they are used to prune trees and shrubs in an informal style.

Pruning saws, 14- to 28-inches long, are necessary for cuts over ¾-inch in diameter. The teeth should have a coarse set, to guard against gumming up the saw. Saws coated with Teflon are also available.

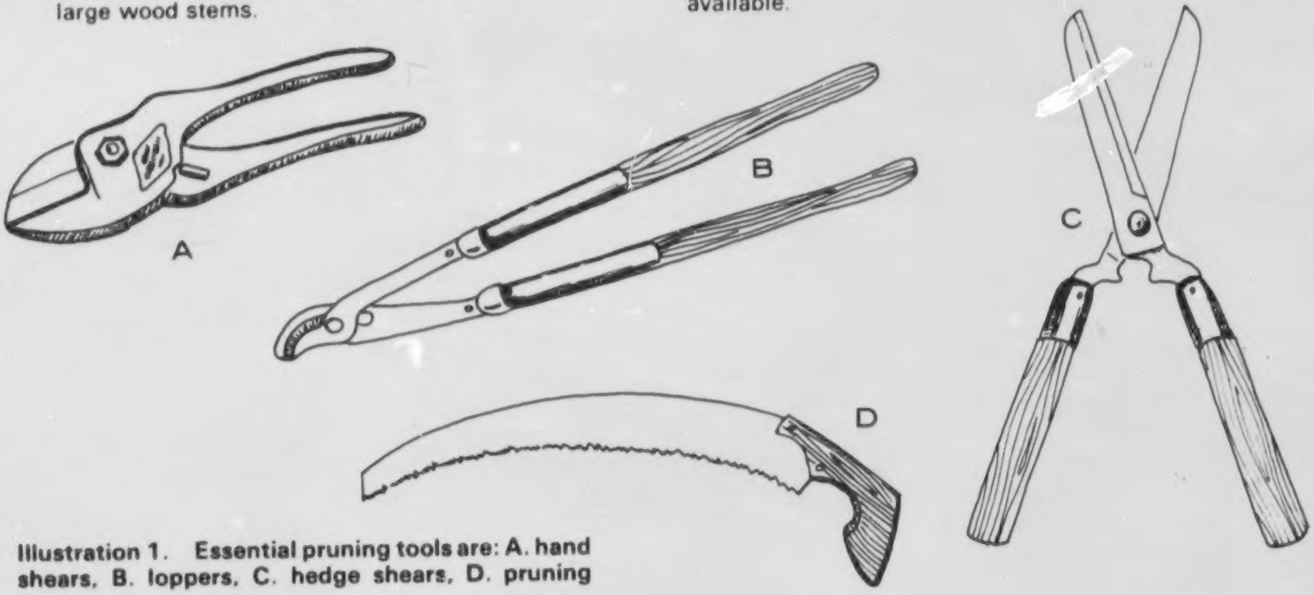

Illustration 1. Essential pruning tools are: A. hand shears, B. loppers, C. hedge shears, D. pruning saw.

Deciduous shrubs and trees

The techniques of pruning are simple, and success is nearly always achieved if they are used. Always allow the shrub or tree to develop its natural shape, except when special effects are desirable, such as for hedges. "Haircut" pruning should be avoided. (See Illustration 2.) The perfectly-sheared globes and squares often seen the full length of the front of ranch style homes are in poor taste from a landscaping point of view. An exception may be for accent plants at the entrance of the home.

Instead, use the thinning technique on both shrubs and trees. Cut the branches at different lengths, ¼-inch above an active bud. Remove twigs or branches selectively and thus reduce overcrowding. Some stems should also be removed at ground level (Illustrations 3 and 4). The length of new shoots should be reduced 1/3 to 1/2 of their length, which induces side shoots to develop.

Cutting above a bud prevents dieback of the stem and a new branch develops from the bud. The haircut technique causes a dense growth to develop at the ends of these branches which shades the rest of the plant, thus causing the plant eventually to develop a leggy appearance. If a shrub develops a weak, dense growth, thin out many of the smaller branches and twigs. This promotes the vigorous growth of the remaining branches. Also remove branches which tend to rub against one another, opening wounds for the entrance of disease.

Always remove dead, damaged, or diseased branches and limbs from established plants as well as newly-planted trees and shrubs. The plants should then develop new, stronger growth, free of diseases. Also, remove dead flower branches, dead flowers and old fruit stocks as soon as the flowers have wilted or the fruit has dropped. This stimulates new growth and helps to make a stronger tree to shrub. It also encourages plants such as rhododendrons to produce more flower buds for next season.

When removing branches cut close to the main branch or trunk, do not leave stubs (Illustration 5). Wounds with stubs do not heal properly and decay often occurs. All wounds over 1-inch in diameter (size of a quarter) should be treated with tree wound dressing. Do not use house paint or tar, but obtain tree wound dressing from the hardware or garden center.

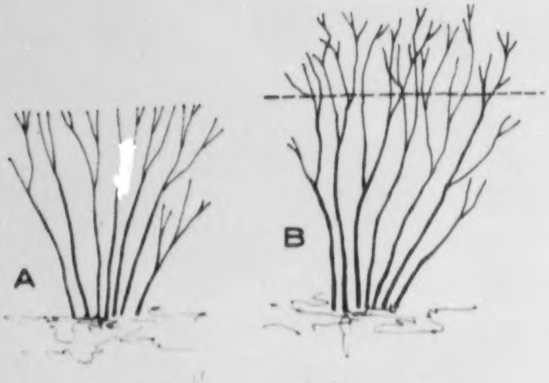

Illustration 2. "Haircut" pruning should be avoided. A. a "haircut", B. new growth occurs only at the top.

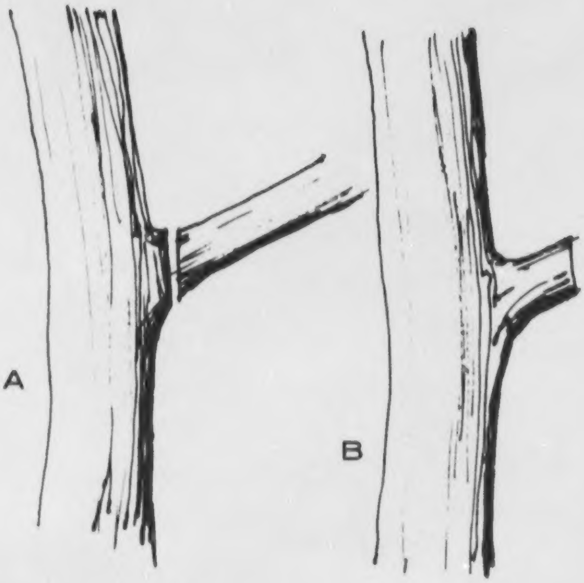

Illustration 5. Remove large branches close to the trunk (A), Do not leave a stub (B).

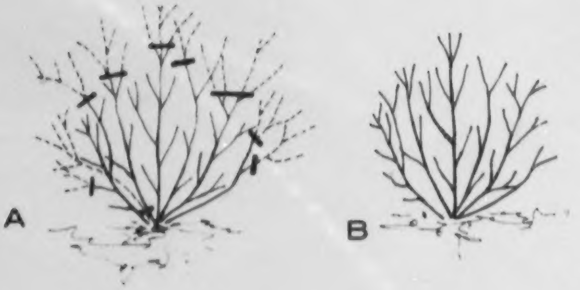

Illustration 3. Use the thinning technique. A. before, B. after.

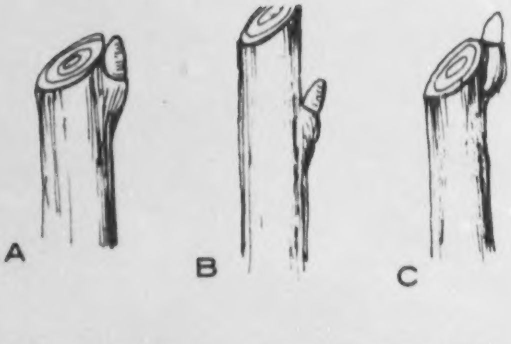

Illustration 4. Cut the branch ¼ inch above an active bud. A. correct cut, B. Stub too long, C. cut too close to bud.

Evergreens

With evergreen shrubs, avoid shearing to artificial shapes. If the evergreen plant has a soft, feathery appearance, do not cut it square or make a round shrub out of it. Prune using the thinning technique previously described for deciduous shrubs, thus keeping the natural shape of the evergreen. Remember, the non-green portion of evergreen branches does not normally put out new branches. Therefore do not cut branches back to the old wood. Reduce new growth annually and when removing the larger branches for thinning, cut close to the main trunk leaving no stubs. Heavy thinning is needed only every few years.

With certain evergreens such as *Taxus* or yews, a new flush of growth will occur in the early fall. Tip back these long shoots to keep the plants in shape.

To thicken the new growth of coniferous trees such as pines, spruce, or fir, remove ½ of the candle (the new growth) when it is approximately two-inches long in the spring (Illustration 6). Do not use shears, but pinch it out. Shears damage the needles that are around the candle and the cut edges turn brown. This gives the tree an unsightly appearance. Do not top or remove the central leader, if the natural growth habit of the tree is desired.

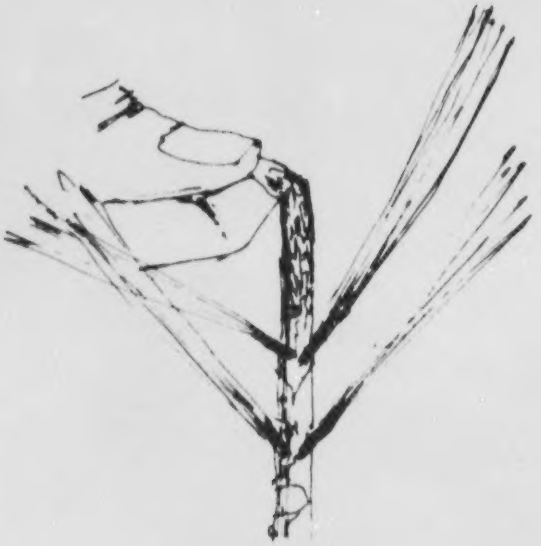

Illustration 6. Remove ½ of the candle when approximately 2 inches long.

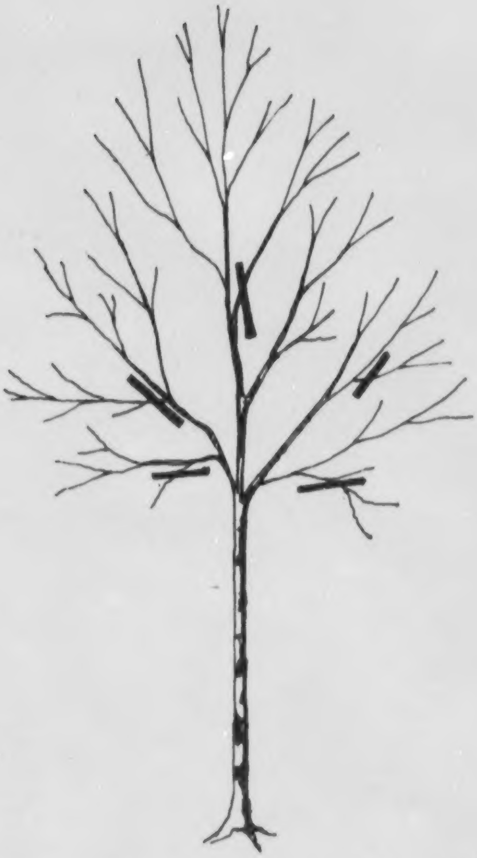

Illustration 7. Use the thinning technique to remove 1/3 of the leaf area of newly-planted trees.

Broadleafed evergreens are pruned in the same manner as narrowleafed evergreens. Holly trees may be pruned at Christmas time. Prune lightly every year or heavily every three years.

Newly-transplanted trees

At transplanting time, bare root trees and shrubs have suffered root damage as well as a loss of roots in the digging process. To compensate for this loss of roots, the leaf area of the plant should be reduced by 1/3 to reduce water loss due to transpiration and evaporation. The natural form of newly planted trees and shrubs should be preserved by thinning. Remove branches and parts of branches by cutting at different lengths as previously described (Illustration 7).

When the tree is approximately 2 years old, establish alternate branching (Illustration 8). This will allow stronger limbs to develop. Also leave those branches which have the widest angle in the crotch, that is, the angle that is formed where the branch is attached to the trunk. The wider this angle, the stronger the crotch (Illustration 9). The main leader forms the central trunk in such trees as tulip tree, sycamore, pin oak, black gum, sweet gum, and shingle oak, and therefore should never be removed or cut back.

The maples, ash, honeylocust, and linden have a modified leader which may be cut back lightly to a lateral twig or bud if desirable.

Rejuvenation

Another aspect of pruning is the rejuvenation of declining shrubs. Large, old shrubs such as honeysuckle, forsythia, and spirea are prime examples (Table 4). In renewal pruning or rejuvenation pruning, remove one-third of the old, mature stems per season. Leave the young vigorous branches. These large, old branches are removed at the ground level. The water sprouts that develop should be cut back to different lengths and encouraged to develop into strong branches for the shrubs by the thinning process (Illustration 10).

Lilac wood often is more than 3 years old before it flowers. Therefore, large overgrown lilac bushes can gradually be cut back over a period of years, but do not remove all the old flowering wood until the new growth begins to flower. Then the bush will flower every year and will not have any barren years.

Some plants are also frequently killed during the winter. These may be safely cut back, and new growth is rapidly produced. These plants are considered to be usefully winterhardy, and can be used for landscaping purposes even though severe pruning and rejuvenation often is necessary (Table 4).

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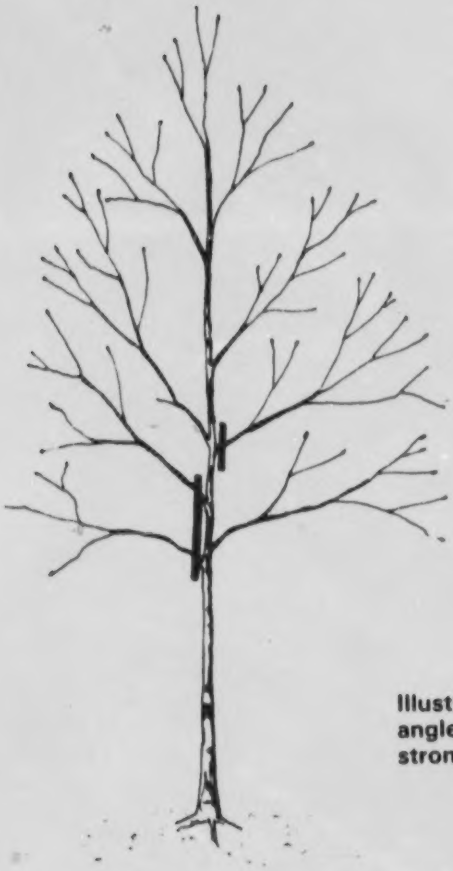


Illustration 8. Establish alternate branching

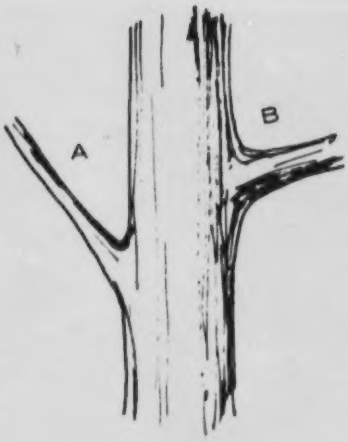


Illustration 9. Remove branches with a narrow angle or weak crotch (A), and leave wide-angled or strong crotches (B).

Table 4. Landscape plants which may be completely cut back to the ground but return to usefulness.

Scientific name	Common name
Buddleia davidii	Orange-eye butterflybush
Clematis jackmanii	Jackman Clematis
Forsythia	Forsythia
Hibiscus syriacus	Shrub-althea
Hydrangea arborescens grandiflora	Hills-of-Snow
Hydrangea quercifolia	Oakleaf Hydrangea
Lonicera	Honeysuckle
Polygonum aubertei	Silver fleece vine
Spiraea	Spirea
Syringa	Lilac

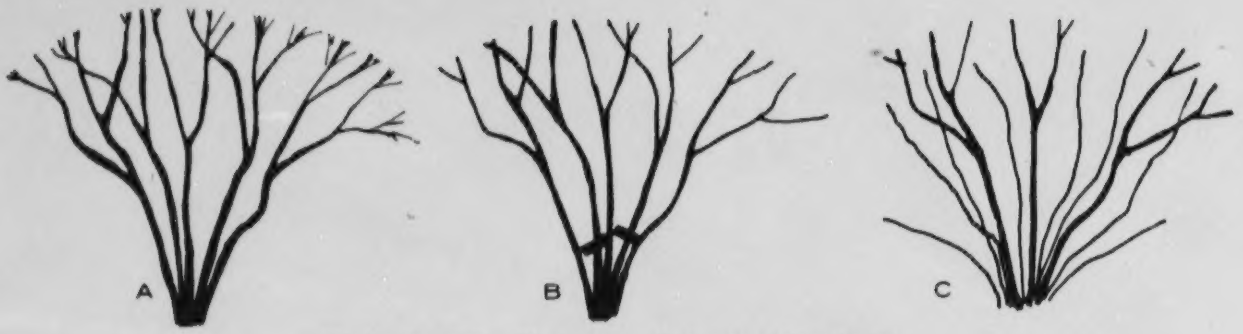
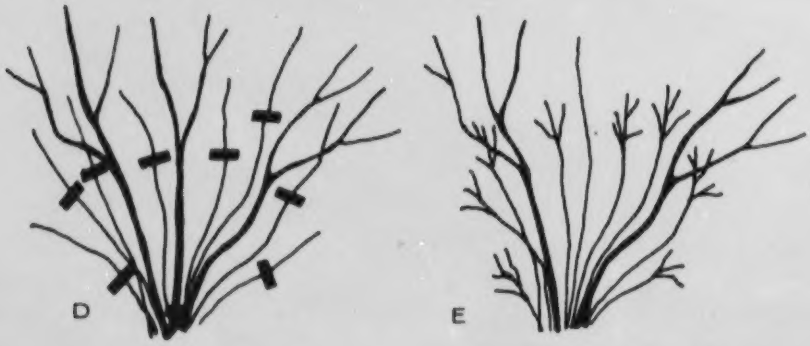
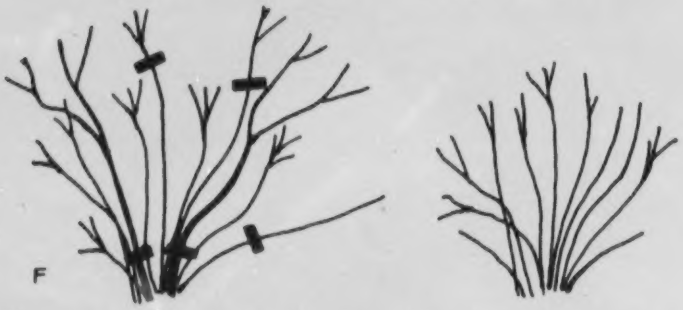


Illustration 10. First year - A. large old bush, B. remove 1/3 of old branches at ground level, C. growth at end of first season.



Second year - D. Use thinning technique to remove 1/3 of old branches, and to cut back new growth, E. growth at end of second season.



Third year - F. use thinning technique to remove remaining old branches and to cut back new growth, G. growth at end of third season (rejuvenated shrub).

Large trees

Proper pruning also helps to prevent injury and damage to life and property. This usually involves the removal of large branches or limbs from trees. Where tree limbs are near power lines, call the power company and ask them to remove them. Do not, (repeat) **do not** try to remove tree limbs from power lines yourself.

Low-hanging branches may cause injury when mowing the lawn or walking on the street. Also branches sometimes rub against the house and its roof. To remove the branches that are over 1-inch in diameter, use the double cut method. If the double cut method is not used, the branch will break and splinter the trunk. This removes a large portion of the bark, causing a large wound which heals with difficulty and may further result in permanent damage to the tree.

To double cut, first cut halfway on the underside of the limb (about 6-inches from the tree trunk). Then (approximately an inch further out) make a second cut through on the upper part of the limb. When the branch is removed, there is no splintering of the main tree trunk. Then remove the stub by conventional methods (Illustration 11). Remember, all wounds over one-inch in diameter (size of a quarter) should be treated with tree wound dressing. This will waterproof the wound, help prevent decay, and promote healing.

Beware of rejuvenation techniques sometimes used on large old trees. Homeowners are sometimes "conned" into having the tops of old trees completely cut back, leaving only the stubs. These stubs eventually decay. Also, since the tree is in such a weakened condition, it may eventually die. If you have large limbs that need to be removed, secure the professional services of an arborist. An arborist can drop work a tree, that is, lower the height, by removing limbs that are causing problems. When completed, the tree will still retain the beauty of its natural shape. Remember, a tree that has a trunk diameter of 20-24 inches is worth approximately $5,000 on a replacement value scale. Therefore, if you have a large, valuable tree, secure the services of a professional arborist.

Hedges

Plants are also sheared to unnatural shapes. Hedges are often improperly pruned with the top trimmed flat and the sides sloped inward so that the base is more narrow than the top. This shades the lower portion of the hedge, the plants become leggy, and the hedge becomes straggly. In proper hedge shearing, the top is shaped more narrow than at the base (Illustration 12). This allows light to penetrate to the lower portions of the plants, growth can be maintained, and a full appearance occurs over the entire depth of the hedge. This simple technique helps the hedge to develop into a satisfactory barrier for a long period of time.

Deciduous hedges that are too leggy to be useful can usually be rejuvenated by pruning them to within 2-6 inches from the ground. By following the previously described practices on the new growth, the hedge can be properly re-established.

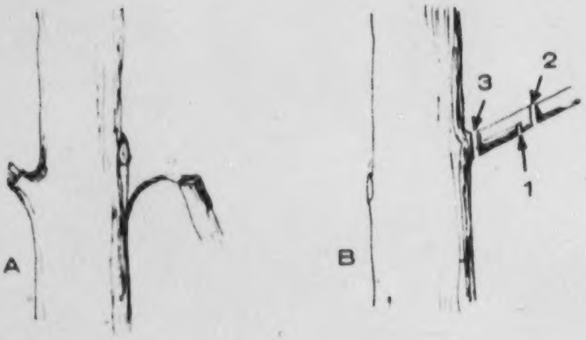


Illustration 11. Remove large limbs with double cut method. A. incorrect method, B. correct method, 1-first cut, 2-second cut, 3-third cut.

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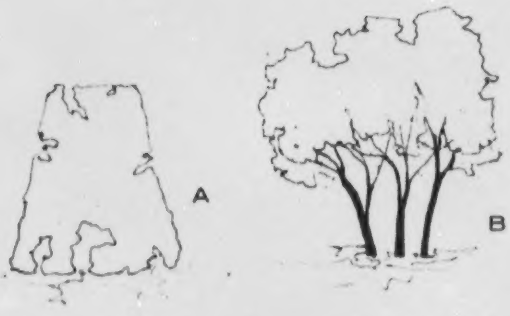

Illustration 12. A properly-pruned hedge (A), and an improperly-pruned hedge (B).

Summary

Follow proper pruning practices

Why

1. Pruning reduces or maintains the size of a tree or shrub.
2. Pruning removes dead, diseased, or broken branches.
3. Pruning stimulates future flower and fruit development.
4. Pruning old, established trees or shrubs rejuvenates them.
5. Pruning decreases danger of injury and/or damage to property.
6. Pruning shapes plants into an unnatural form.

When

1. If a tree or shrub flowers before the end of June, prune immediately after flowering.
2. If the tree or shrub flowers after June 30th, prune during the winter or immediately before the new growth starts.
3. Evergreens may be pruned at any time of the year when the wood is not frozen.
4. Avoid late summer pruning in August through mid-September.

How

1. Always thin a shrub or a tree, and allow it to develop its natural shape.
2. Do not leave stubs.
3. Paint all wounds over 1-inch in diameter with a tree wound dressing.
4. Establish alternate branches, and do not remove a central leader on trees.
5. Leave limbs which have a strong, wide-angle crotch.
6. Use the double cut method when removing large limbs over 1-inch in diameter.

HO-71

SOIL SAMPLING FOR HOMEOWNERS

John A. Wott

It is an all-too-common practice for many homeowners to apply fertilizer, lime, sulfur or other materials to their soils indiscriminately and, often, unnecessarily. And sometimes this may do more harm than good by altering the soil characteristics. However, testing soil at periodic intervals can keep tabs on the soil's ability to supply nutrients needed for best plant growth. It's good to remember, too, that the old adage "if one pound is good, two is better and three is best" does *not* hold, for things like applications of fertilizers, lime, or sulfur or even for organic matter, manures and the like.

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Most plants will grow satisfactorily within a wide range of soil pH, which is a measure of acidity or alkalinity. But usually a pH of 6.1 to 7.0 (just slightly acid) is best for most plants. But, the only way to determine the pH of the soil is by a soil test! And apply lime or sulfur *only* on the basis of this soil analysis.

Nutrient levels in the soil such as nitrogen, phosphorus and potassium, also change from growing and harvesting plants, leaching, and erosion. A soil test will also reveal the current nutrient status and whether additional nutrients should be added as fertilizer.

The pH of the soil also affects the availability of most nutrients. Most nutrients are most available to plants at a pH of 6.5.

To get an accurate soil test, soil samples need to be carefully collected and prepared.

When to test

A soil test once every three years is usually adequate. However, if fertility and pH levels for specific plants are important to your plans, then test more often.

Take the soil sample before planting, so there is time treat the soil. Soil samples can be taken any time the soil is suitable for spading or rototilling, but late summer or early fall usually permits the least possibility of contamination from fertilizer applied during the growing season. But, if a problem which suggests that soil fertility may be at fault develops, collect samples immediately. Having soil samples from the "normal" and "abnormal" plant growth areas is always helpful for comparison.

Tools

Soil sampling does not *require* a special tool, but some tools work better than others. A soil probe or auger is ideal, but a sharp spade, long knife or trowel can be used if you remove the same amount of soil from each sampling area. A *clean* pail or box for holding the sample is important.

Techniques

Always remove debris, such as residues or turf thatch, from the soil before inserting the soil probe, spade, or trowel.

Sample areas of the yard separately and outline the differences. Prepare a diagram showing where the samples were taken.

- Sample gardens, shrub and flower beds to a depth of 6-8 inches.
- Sample turf areas to a 3-inch depth.
- Sample row crops (in gardens) between the rows to avoid fertilizer bands.
- Sample light, dark-colored, limed and unlimed areas separately.
- Sample front and back yard separately if they have been handled differently, or contain different types of fill soil.

Composite sample

Since only a small portion of the soil is used for testing, it is very important that the sample be representative of the area. Usually, it is better to prepare a single soil sample of several cores or slices rather than to have several tests made within the area. So, after you have chosen the main areas to be sampled (front yard, back yard, garden etc.), take several samples from the area. Mix these together to get your representative sample or "average" for the area. For large areas, 10-15 cores are needed, but for shrub borders 4-6 will do the job. Be sure to take all samples and place them together in a clean pail or box. Be sure to keep an accurate record of the sampled areas and include this information in the soil report (called a field record), so you'll be able to interpret the results.

Handling samples

- Allow the samples to dry at room temperature. Do not use artificial heat.
- Break up any lumps and remove all stones, debris, etc.
- When dry, mix well and crush so all the soil is the size of wheat grains or smaller. Do not pulverize.
- Remove one pint per composite sample and place in a clean container. Identify the bag or box so you will know the area from which it came.

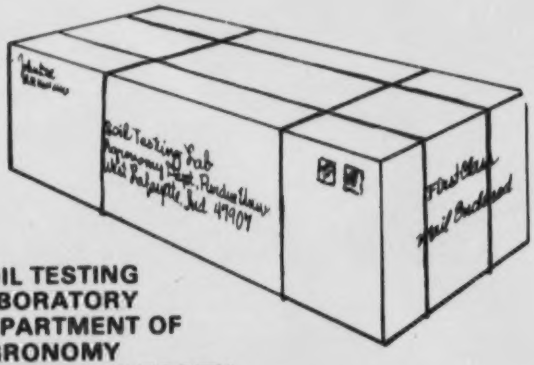
Mailing instructions

Contact your County Cooperative Extension Service Office for soil testing forms and containers which are especially prepared and available free of charge. The staff can also help with the information sheet which should accompany the sample and will provide you with a container to ship your samples. Be sure to list all plants and cultural practices used.

The service charge for a routine soil analysis, which is performed by the Soil Testing Laboratory at Purdue University, is $2.00 per sample. This includes a pH test, lime requirement test, and analysis of phosphorus and potassium content.

Place your sample bags in shipping container provided by your county agent. Place the information sheet with remittance in an envelope, seal it, and enclose it with the samples.

Write your name and return address in the space provided. Tie or wrap securely and send via Parcel Post, or United Parcel Service to the following address:



**SOIL TESTING
LABORATORY
DEPARTMENT OF
AGRONOMY
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA
47907**

Important Postal Regulation:

The statement "First Class Mail Enclosed" must appear on the carton if your information sheet is inside the carton.

When the samples are sent for testing, they must be accompanied by the information sheet, properly filled out, and the $2 remittance to cover the cost of testing. Make check or money order payable to Department of Agronomy, Purdue University. Samples without remittance will be held while notification is sent. If no reply is received within 30 days, samples will be discarded.

Results

Your soil test results will be returned to you, with a copy to your County Extension Office.

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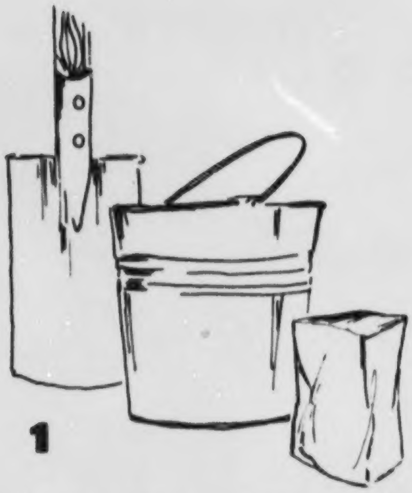
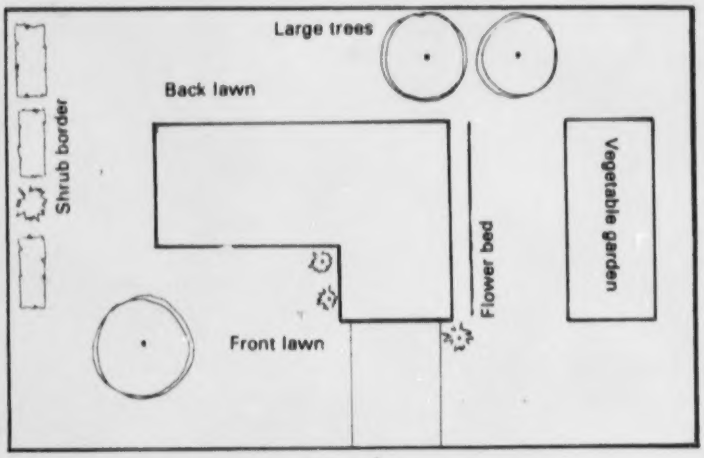
HOW TO TAKE A SOIL SAMPLE AND PREPARE IT FOR TESTING



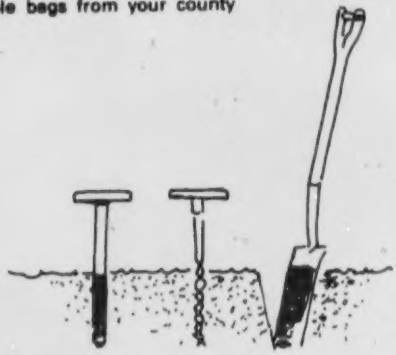
1

To take the sample, you will need a sampling tube, auger or spade and a clean pail. Get sample bags from your county agent.



2

Sketch the areas of the home yard.
Sample the areas of the yard separately.



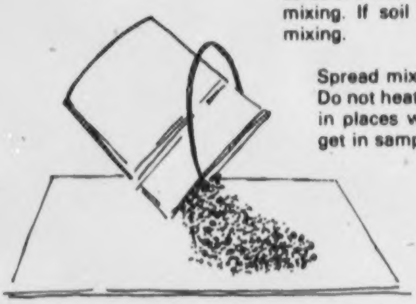
3

Sample to proper depth. If a spade is used, dig a V-shaped hole, then remove a slice from the side.

4

Place cores or slices in a clean pail. Mix them together thoroughly, breaking up the cores or slices. If soil is muddy, dry it before mixing. If soil crumbles easily, dry after mixing.

Spread mixture out on clean paper to dry. Do not heat in oven or on stove. Do not dry in places where fertilizer or manure may get in sample.



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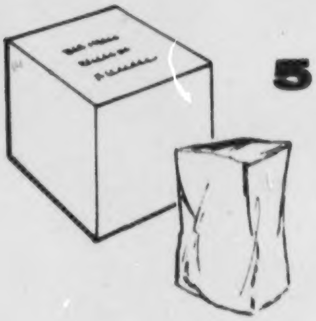

Identify the sample and record the area, plants used and any previous cultural treatments on the information sheet.

Fill the waxed sample box with the air-dried mixture of soil. Discard the rest. Label and number the sample box. Be sure the numbers correspond to your sample numbers on your sketch.

AY-1
1977

the grass is greener
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TEN STEPS TO A GOOD LAWN

by W. H. Daniel, Extension Agronomist

Few areas of the homeowner's maintenance chores demand as much time and attention as lawn care. A neatly-kept, healthy, green lawn can be a lovely asset to the home. If you follow a continuing lawn-care program, it can be achieved with a minimum of effort and expense.

These ten steps to a good lawn have evolved from more than two decades of turf studies. Each step leads to its successor, and they are all based on a single, vital factor—a good, rich soil for adequate moisture and nutrient storage.

If you are a real lawn enthusiast, you may be interested in following all ten steps. Other, less involved persons may be interested in just the first few. However, each builds upon the other, and you can, by following those that are applicable to your own situation, devise a good program of lawn care.

The steps are:

1. Use adapted grasses.
2. Mow regularly.
3. Fertilize at least twice.
4. Kill broadleaf weeds.
5. Irrigate to maintain growth.
6. Reduce competition from crabgrass.
7. Prevent insect damage.
8. Make room for new leaves by removing thatch.
9. Protect from diseases.
10. Kill patches of undesirable grasses.

Step 1. Use adapted grasses

Bluegrasses are favorites in the Midwest. Common, Delta Glade, Park, Adelphi, Baron, Merion, Victa and Wabash bluegrass varieties may be blended for greater disease resistance and longer vigor. Often redtop or ryegrass are added for early growth. Red fescue may also be added for shade. Always buy good quality seed, based on purity (freedom from weed seeds) and bluegrass percentages. Zoysia may provide a dense cover on droughty soils in sunny areas in the southern portion of Indiana.

Step 2. Mow regularly at correct height

At a two-inch height, bluegrass lawns will withstand disease damage and weed competition better than if cut more closely. The newer, more disease-resistant varieties can be cut at 1-1½ inches. Bent, Zoysia and Bermuda grass should be cut to less than one inch. Sharpen your mower blades monthly.

Step 3. Fertilize two or more times annually

Your lawn is a mixture of dead, dying and growing blades of grass and you want to keep the green ones predominant. This means feeding the lawn at least twice a year, using a fertilizer that is high in nitrogen, low in phosphorous and medium in potassium content, such as 16-8-8, 12-4-8, 19-5-9, 24-4-12 and 30-3-10 mixtures.

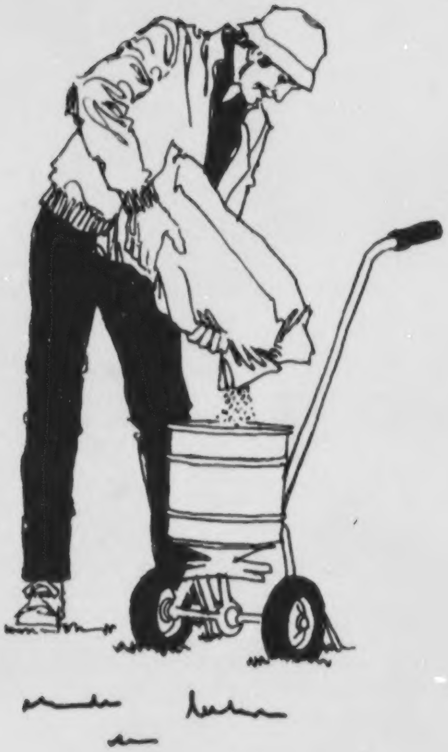
Many lawn fertilizers today are non-burning, slow release, lightweight, granular types. These can be applied any time the grass leaves are dry without damage. But, for safety in areas where there is wear on the turf, and for quick response, water immediately.

Step 4. Kill broadleaf weeds

Treat any time, but the best time is mid-fall. Use the amine form of 2,4-D, which is available either as a liquid for sprayers, in dry form, in fertilizers, as a weed stick, and even in aerosol cans. Apply uniformly and follow label directions carefully.

Step 5. Irrigate to keep the lawn green

To keep your turf green and growing, water it regularly. However, water can become expensive and scarce. So, some prefer to let their lawns go dormant in periods of drought. Do water enough, however, to insure fall recovery. Water is not a substitute for fertilizer.



Step 6. Prevent crabgrass

A number of proven crabgrass preventives are now available at local garden stores. To be effective, any of these products must be present near the soil surface in adequate amounts when crabgrass seedlings begin. Therefore, timely, sufficient and uniform application is the key to success to crabgrass control. You may treat the entire lawn, or only a portion. Without competition from pesky crabgrass, it is easier to keep bluegrass lawns dense and healthy.

Step 7. Prevent insect damage

Insect control in lawns is easy, and is not frequently needed. However, knowing what and how to do it is important to success. Treat for grubs in April, using insecticides such as Diazinon, Dursban or Dylox. One application should give control for 3-5 years. Occasionally, sod webworms will eat grass leaves in summer. Two sprays with Dylox, Sevin, Diazinon, Dursban or Spectracide will stop activity. The best time for their control however, is in mid-May to kill the larvae of the first brood.

Step 8. Make room for new leaves

In early spring, remove the brown tips of old growth to manicure your lawn and let the new growth show earlier. Close mowing, plus sweeping, then fertilizing, makes a spring lawn the brightest. In early fall, power rakes and thinners do a good job of thinning. They can reduce crabgrass and weeds, as well as removing much of the thatch and old clippings.

Step 9. Protect against diseases that kill leaves

Fungicide use is time-consuming and costly and demands considerable management. Be sure you have correctly diagnosed the disease and select the appropriate chemical for treatment. Then, apply the treatment before the damage becomes severe. Over-watering, over-fertilizing or mowing too short all help to encourage lawn diseases.

Step 10. Kill unwanted patches

To have that perfect, smooth look, kill unwanted patches of clover, bent, etc. However, be cautious in trying selective killing. You can overdo it, or it may disfigure and discolor areas for long periods. Resodding may be preferable. Check with your local sod supplier for information on this. If your unwanted patches are sufficiently bad, you may want to kill everything and just begin again.

The new green vegetation killer glyphosane offers complete lawn kill and permits reseeding after a 1-3 day waiting period.

Related publications

For additional information, see:

AY 5 Varieties and Mixtures for Lawns
AY 6 How Does Zoysia Look for Midwestern Lawns?

These publications are available at your County Extension Office, or Mailing Room, Agricultural Administration Building, Purdue University, West Lafayette, IN 47907.

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YARD & GARDEN

HORTICULTURE DEPARTMENT • COOPERATIVE EXTENSION SERVICE • PURDUE UNIVERSITY • WEST LAFAYETTE, INDIANA 47907

HO-100
1977

PLANTING ORNAMENTAL TREES AND SHRUBS

by John A. Wott, Extension home environment horticulturist and Philip L. Carpenter, Extension horticulturist

Proper planting of ornamental trees and shrubs helps insure the success of a landscape. Trees are used in home landscapes to frame a home, provide background, give shade, and provide accent. In the same manner, shrubs are used as border or screen plantings, foundation plantings or as accent plants.

Plan before action

First obtain a basic landscape plan for your home. This locates existing trees and shrubs in relation to the dimensions of the lot, house and driveway. The location of underground utility wires, sewer tile, and septic lines, as well as overhead wires that might hinder the future top growth of large trees, should be shown on the plan.

Select trees and shrubs which will fit the scale of the lot. Allow for the mature height and spread of the plant.

Planting distances to consider are:

distance from the house or utility wires
distance from sidewalk, drive, lawn
distance from other trees and shrubs

Generally, plants should be placed at one-half their mature height from each other and from existing physical objects (Figure 1). To avoid the hazards of falling objects, such as branches, fruit, nuts, etc., plants should be placed 2/3 to 3/4 their mature height from sidewalks or driveways. A nurseryman should be able to tell the mature height of the plant.

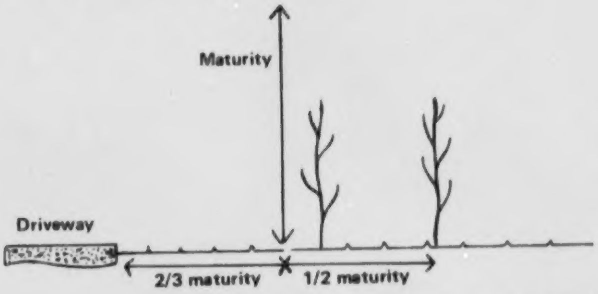


Figure 1: Generally, plants should be planted one-half their mature height from each other and 2/3 their mature height from sidewalks or driveways.

When to plant

Most trees and shrubs should be planted before the new growth starts in the spring, or in the late fall when growth has stopped. The plants are dormant at this time and there is a greater chance for establishment and growth after transplanting.

Trees and shrubs may be purchased as: (a) bare root, (b) balled and burlapped, or (c) container-grown plants (Figure 2). Bare root plants are usually more economical to buy, but more difficult to establish. In Indiana, they are best planted only in the spring.

Most evergreens and large trees are balled and burlapped and should be planted either in the spring or fall. Trees and shrubs planted in the fall should be balled and burlapped. Potted and container-grown stock can be planted at any time of the year when the soil is not frozen.

Exceptions to the rules are plants with fleshy roots, such as yellow-wood, magnolia, dogwood, tulip tree, and sweet gum. They should be planted only in the spring, regardless of their container.

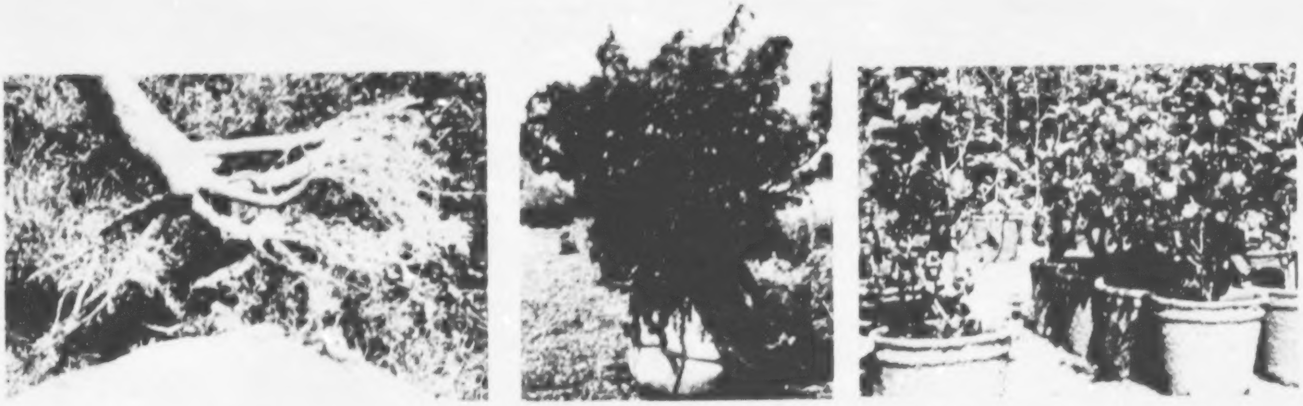


Figure 2: Plants may be purchased as a) bare root b) balled and burlapped c) container-grown.

Planting site

The adjustment of soil conditions is the most important step in the planting operation. Soil types vary, not only between areas of the state, but also between areas of a single yard. Often subsoil and fill dirt are added to the yards of new homes, drastically changing the soil type within a short distance. This, and the possible presence of drainage problems, may affect the choice of plant as well as the planting technique. The planting technique must be modified to meet the requirements of the plant and the site.

Planting bare root stock

Most plants can be prepackaged. Carefully remove them from the packing material and examine the roots. Cut off damaged roots with a sharp knife. It is advisable to soak plant roots overnight in water; but do not allow the roots to stand in water for more than 12 hours.

Since most of the roots are exposed on bare-root stock, it is absolutely essential that the plants be protected until they are planted. Do not let the plant roots dry out by exposing them to the air and sun, even while digging the hole. Keep the plants in a cool storage area, and cover the roots with moist peat, sphagnum moss, or damp burlap. Plant as soon as possible.

Place a sheet of plastic near the spot where the tree or shrub will be planted. Place the soil on the plastic as you remove it from the hole. This allows for easy mixing of the soil and clean-up. In well-drained soil, dig the hole at least one foot wider and four to six inches deeper than the natural spread of the roots (Figure 3). Do not slope the sides of the hole, but leave them absolutely vertical to the bottom of the hole.

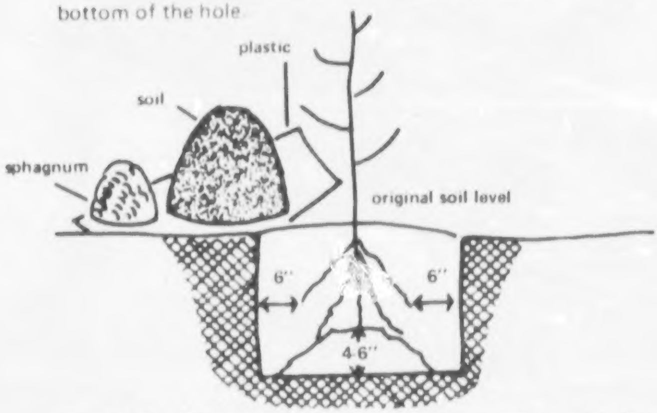
After the soil has been removed, mix the top soil and the subsoil together. Thoroughly mix one part of a good grade of sphagnum peat moss with two parts of the soil.

Put the soil mix in the hole (about four-six inches) and position the plant at exactly the same level that it was previously growing. **Never place the plant deeper than it was originally growing.** Place it in the center of the hole, with six inches of space around the outside of the root spread. Hold the plant in position and carefully fill in the soil mix around the roots. Work the soil mix in around the roots and firm the soil with your hand. **Do not tramp or pack the soil tightly!** Continue filling the hole until it is 3/4 full.

Now fill the hole full of water and let it soak away. This settles the soil and eliminates air pockets around the roots. Do not pack the soil after it is watered. Straighten the plant if necessary, and finish filling the hole with soil.

Form a two-three inch rim of soil around the edge of the hole to form a shallow basin (Figure 4). Prepare a fertilizer solution with a water soluble fertilizer of an approximate analysis of 20-20-20 by **adding one level tablespoon of fertilizer to one gallon of water.** Fill the basin with the fertilizer solution. Usually two-three gallons is necessary for each plant. **Do not use any more fertilizer at planting time or during the first growing season.**

After watering, add a mulch of two-three inches of peat, bark or other coarse material. Be sure to keep the rim around the edge to catch water during rains and for each watering during the summer. Bare root stock should also be pruned as outlined later.



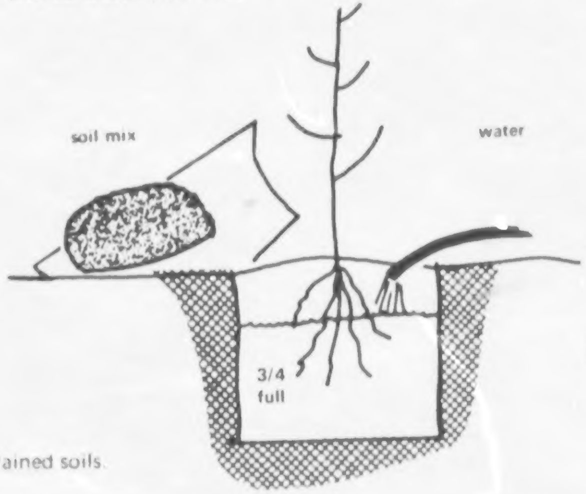


Figure 3: Planting of bare root trees and shrubs in well-drained soils.

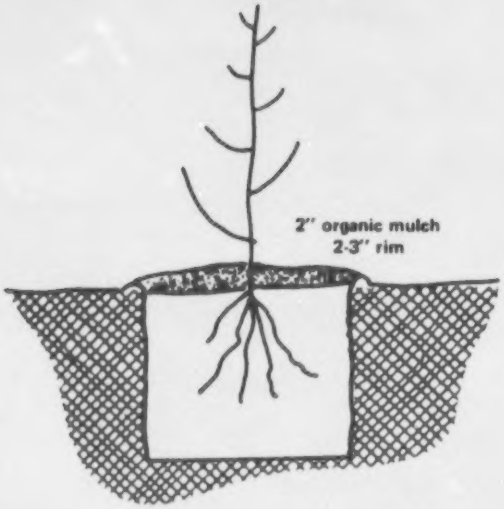


Figure 4: Completion of planting bare root trees and shrubs.

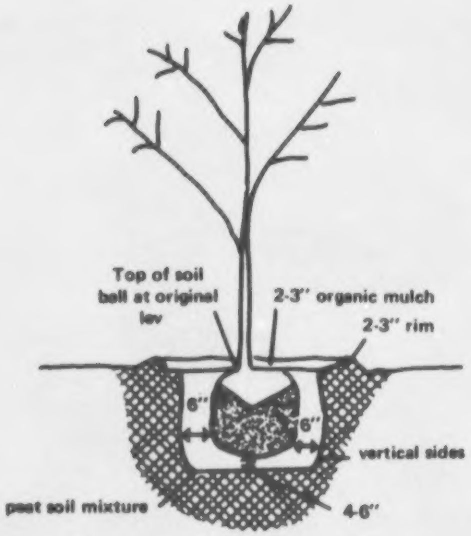


Figure 5: Planting of balled and burlapped trees and shrubs in well-drained soils.

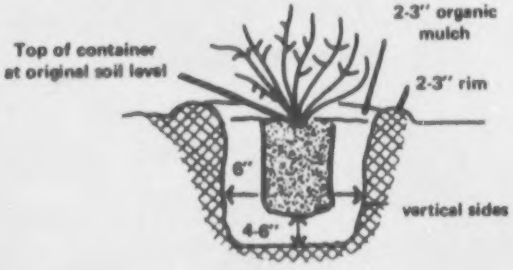


Figure 6: Planting of container grown trees and shrubs in well-drained soils.

Planting balled and burlapped stock

Procedures similar to those outlined for bare root plants are followed for balled and burlapped stock (Figure 5). In well-drained soil, dig the hole one foot wider and six inches deeper than the size of the ball. Prepare the soil mix as previously outlined – 2/3 soil from the hole and 1/3 peat moss by volume.

Handle the plant carefully! Do not remove the burlap and do not drop the soil ball. Handle the plant by the soil ball – not the trunk of the plant.

Fill the hole with enough of the soil mix so that the top of the soil ball is level with the soil surface. **Never plant deeper than this.** This insures that the plant will be at exactly the same depth as it was originally. Fill the hole 3/4 full with the soil mix. Cut the top of the burlap away from the top of the soil ball. Fill the hole with water and allow it to settle.

Finish filling the hole, prepare the shallow basin, fertilize and mulch as outlined previously.

Planting container-grown stock

Container-grown stock can be planted at any time of the year. Follow the same procedures outlined for balled and burlapped stock (Figure 6). Handle the plants carefully, and prepare a hole one foot wider and six inches deeper than the size of the container. Dig the hole before you remove the plant from the container.

Some plants are also available in papier mache' containers. There are two types of these containers available, one which decomposes rapidly, and the other, a more permanent type. Plants in the type that decomposes rapidly are not removed from the container before planting. However, remove them from the more permanent type before planting. Check with your nurseryman about the decomposability of the container.

Always remove metal or asphalt containers. Plants in asphalt containers usually have been in the pots for less than a year, and so their roots do not hold the soil together well. Asphalt containers can be cut up the side, the bottom removed, and then lowered carefully into the hole. The top of soil in the container should be level with the top of the hole. **Never plant deeper.** After the hole is partially filled, carefully slip the precut pot out.

Plants in tapered metal containers can often be removed by turning the can upside down and giving the rim a sharp tap on a raised surface. If the can has straight sides, cut down on opposite sides of the container, fold back the metal, and carefully remove the plant. Often the nursery will be glad to cut the metal container for you. It is **extremely important that the soil ball not be broken on container-grown stock, especially if the plants are actively growing.**

Fill the hole, water, fertilize and mulch as outlined previously.

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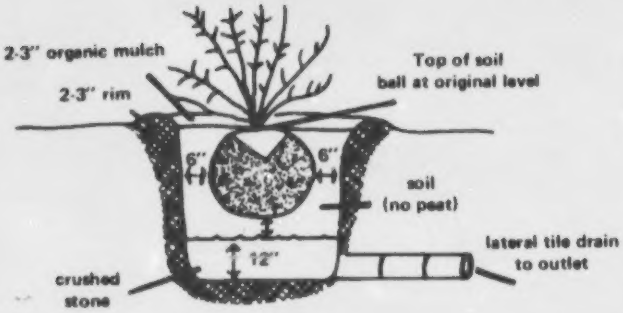
2-3" organic mulch
2-3" rim
Top of soil ball at original level
6"
6"
soil (no peat)
12"
lateral tile drain to outlet
crushed stone

Figure 7: Planting in poorly drained or heavy soils.

Planting in heavy soil

Many areas have a high percentage of clay soil or are poorly drained. If the tree or shrub is to be planted in a poorly-drained area, special steps should be taken.

Dig the hole one foot deeper than in a well-drained area, or 18 inches deeper than the bottom of the soil ball or the roots of a bare root plant (Figure 7). To aid in drainage add crushed stone at the bottom of the hole to a depth of one foot. Then add six inches of soil before setting the plant. **Do not** mix peat with soils that are poorly drained, as peat only increases the water holding capacity of the soil.

Set the plant at the same level that it was originally growing and finish filling the hole, watering, fertilizing and mulching.

If the area is very poorly drained, a lateral tile drain may be needed to remove excess water from the plant area to a drainage outlet.

Plants which will not tolerate wet areas, such as *Taxus* or yew, should never be placed in poorly drained areas, regardless of the planting techniques used.

On poorly drained soils, raised beds are often used for planting trees and shrubs (Figure 8). Use a mixture of 1/3 sand, 1/3 soil and 1/3 peat moss. Make the bed at least two feet high for shrubs and more than three feet high for trees. The width should be at least four feet for a shrub and six to fifteen feet for a tree. For single plants, a wall may be placed around the raised bed to prevent the soil from washing away. For larger areas or groups of plants, the outer edges may be sloped to the original level of the soil. This method should be used only when absolutely necessary.

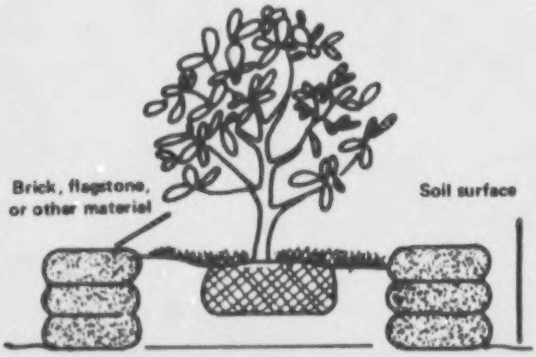

Figure 8: Planting of tree or shrub in raised bed.

Protection

The trunk of a newly-planted tree should be wrapped from the ground level to the first branch with a commercial tree wrapping. To prevent borer attack coat the tree trunk with a commercial insecticide prior to wrapping. Consult your nurseryman for the latest recommendations.

Planting in sandy soils

Ordinary sandy soils pose no particular planting problems. To conserve moisture, mix at least 1/3 peat moss with the sandy soil removed from the hole.

For extremely sandy soil, obtain some fertile loam soil. Then prepare a mixture of 1/3 loam, 1/3 peat moss, and 1/3 original sand soil (Figure 9). It is often advisable to dig the hole larger than ordinarily recommended, but set the plant no deeper than it originally grew. Fill as recommended previously and add at least a three-inch layer of mulch outward from the trunk to a point several feet beyond the width of the planting hole. Water thoroughly once a week throughout the first season. Watering throughout succeeding growing seasons may be essential.

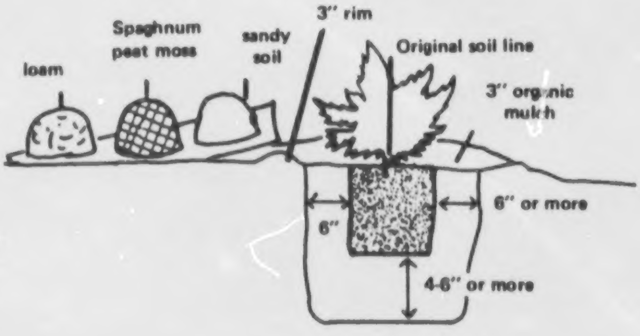

Figure 9: Planting in sandy soil.

Staking

Bare-root trees more than six feet tall and balled and burlapped trees of more than ten feet should be supported by staking to prevent excessive movement (Figure 10). Usually a system of three wires attached to three stakes, fastened about 2/3 of the height of the trunk is sufficient. The stakes should be driven in firm soil outside the soil ball at least twelve inches. Anchor the wires securely. Each wire should pass through a rubber hose where it is looped around the tree. Be sure the loops around the trunk are very loose to prevent damage to the tree. Remove the supporting wires within one year after planting.

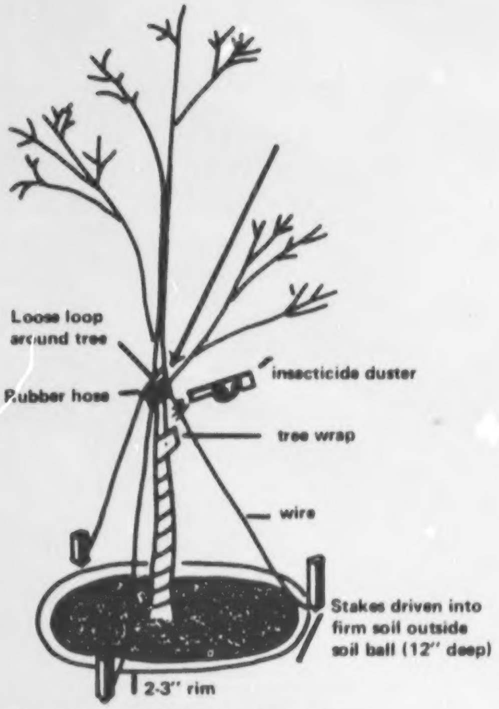

Figure 10: Staking and wrapping tree.

Pruning

Balled and burlapped stock, as well as container-grown stock, does not usually need pruning when planted; but remove any diseased or damaged branches. Follow proper pruning techniques.

Bare root stock should be pruned at planting time (Figure 11). Remove at least 1/3 of the branches on shrubs by thinning. Likewise, on trees remove 1/3 of the branches back to the main trunk. Do not remove the central leader. Consult the publication HO-4, *Pruning Trees and Shrubs* for detailed instructions.

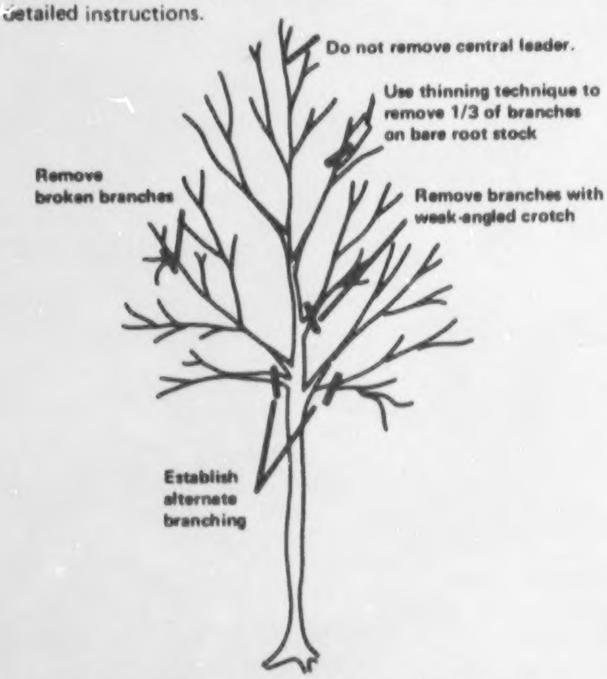
Do not remove central leader.
Use thinning technique to remove 1/3 of branches on bare root stock
Remove broken branches
Remove branches with weak-angled crotch
Establish alternate branching

Figure 11: Pruning newly-planted trees and shrubs.

Watering

The most important factor in caring for newly-planted trees and shrubs is water. You must provide the correct amount of water, for overwatering is just as injurious as underwatering. The soil type and the amount of rainfall will determine the frequency and amount of water needed.

On well-drained soils, apply one inch of water per week during the summer and fall. In sandy soils, at least two inches of water per week is needed. Poorly drained, clay soils will require less frequent watering.

Water regularly and supplement normal rainfall. Do not just sprinkle by using light waterings. A brief rain shower of 1/2 inch should be supplemented by additional watering. If a heavy rain occurs (two or more inches), additional watering may still be needed the following week, not in two weeks.

On bed areas, apply one gallon of water per 1½-2 square feet of bed area. This will add one inch of water to the area. Multiply the diameter of the area times itself to obtain the square feet. Then add the water slowly to allow it to soak into the soil.

Another method is to use a lawn sprinkler. Place a pint or quart tin can near the trees or shrubs and water until the bottom of the can contains one inch of water. Do not use a can with a small mouth or tapered sides.

Transplanting

Occasionally there is a need to move a tree or shrub from one location in a yard to another. Root pruning should be carried out over a two-year period before the plant is moved. Relocation of large trees is best left to professional arborists or nurserymen.

To transplant trees, measure out one foot for each inch of the trunk diameter at waist height. For example, a tree with a diameter of one and one-half inches should be root pruned at a point of 18 inches from the trunk. For shrubs, make the cut one-half the distance of the branch spread of the shrub. For example, a shrub with a spread of 36 inches from the center to the outside of the shrub should be root pruned at 18 inches.

During the first year cut straight down around one quarter of the plant on opposite sides. Use a sharp spade to cut 18 inches deep. During the second year use the same procedure to cut around the remaining two quarters of the plant. This cuts off many of the long roots and encourages many new roots to grow within the soil ball. The plant is then ready to move at the third season.

Dig down around the line where root pruning occurred and throw the soil away from the root ball. Dig a hole 18 inches deep. When the circular hole is completely finished, gently rock the plant (with the soil ball attached) from side to side. Cut the roots on the bottom of the soil ball and slide the burlap under the ball.

Grasp all four corners of the burlap and lift the soil ball from the hole. Wrap the burlap tightly around the soil ball. Tie the burlap so that it will not loosen in handling. Handle the plant carefully, lifting by the soil ball, not by the trunk. **Do not break the soil ball!** Plant as previously described.

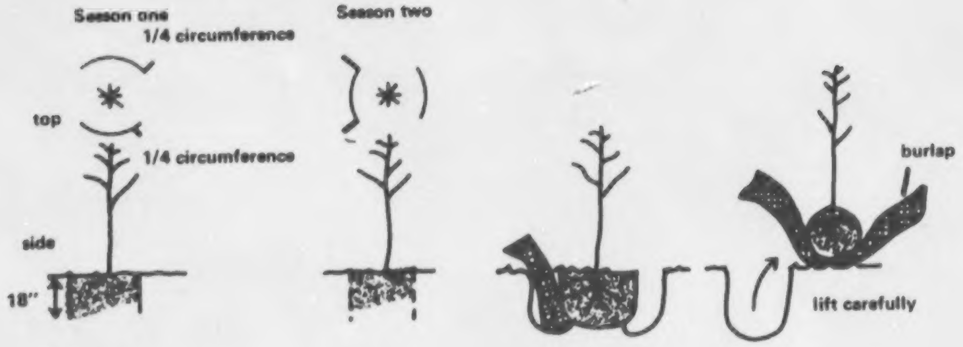

Figure 12: Transplanting a tree or shrub.

Summary

1. Plan before planting. Have a landscape plan.
2. Handle the plants carefully at all times.
3. Follow the rules on planting time.
4. Make the hole large enough, at least one foot wider and four-six inches deeper than the soil ball, container, or bare root spread.
5. Never plant deeper than the plant was originally growing.
6. Carry out an accurate watering program for the entire first season.
7. Do not fertilize except at the first watering.
8. Support tall trees by at least three wires and stakes.
9. Prune bare root stock to help the plant become established.
10. Take proper precautions when planting in heavy and/or poorly-drained soils.

Related publications

Contact your county Extension office or Mailing Room, Agricultural Administration Building, Purdue University, Lafayette, Indiana 47907 for related publications.

HO–4	Pruning Ornamental Trees and Shrubs
HO–25	Plants for Problem Areas
HO–81–1	Some Woody Ornamental Plant Materials for Indiana
BP–2–4	Leaf Scorch of Shade Trees
BP–2–10	Winter Injury and Drought to Ornamental Evergreens
E–29	Scab Insects on Shade Trees and Shrubs
E–82	Common Tree and Shrub Pests

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HOUSE PLANT CARE

John A. Wott

House plants can help create a pleasant home environment. Small plants can add color and scenery to windows or tables, while larger ones can soften and blend with groups of furniture. An important part of the 'indoor landscape,' plants can create a feeling of spaciousness and cool, even in the warmest weather.

If you have often been puzzled as to why some house plants thrive, while others refuse to flourish, even with tenderest care, this publication is for you. Most house plant problems can be easily corrected, and even more easily prevented.

First, realize that most of the foliage plants known as house plants are really native to tropical forests. Therefore, it is necessary to create an environment that meets the basic requirements of a very tropical creature. This is why, for instance, most house plants prefer a humid atmosphere and indirect light. Of course, there are exceptions, and these are discussed also. Keep in mind that good, sound cultural methods, preventive care, and careful attention are the best substitutes for a green thumb.

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Light

Plants vary considerably in their light requirement. For example, plants such as the Croton need direct sunlight, while Philodendron will grow under low light intensities. If plants are grown in insufficient light their leaves turn yellow and die.

In this publication is a partial guide to the light requirements of some common houseplants. Use it as a guide for the selection and placement of your house plants.

If window sill space is in short supply, hang basket planters, make glass shelves, or build a "bay window greenhouse" by extending the window and adding shelves for plants requiring higher light intensities. Light from reading lamps is also beneficial, but the new "broad spectrum" fluorescent lights are usually better. Generally, artificial fluorescent light 10 to 14 inches above the plants will provide sufficient light for plants requiring medium light intensity, such as the African Violet. A combination of ½ warm white to ½ cool white light is best. If they appear spindly, plants need more light or should be closer to artificial light. For even growth, turn the plants once a week so they receive uniform light on all sides.

Temperature and ventilation

Most house plants grow well between 60 and 75°F. They may be spindly if kept warmer. Always keep them away from hot or cold drafts, warm appliances and heat registers. Flowering plants will retain blossoms longer if lower temperatures are provided. Temperatures above 75°F. hasten the death of flowers and make plants more spindly as well as less resistant to disease and insect attack.

Some plants will thrive in hot and dry conditions, often managing to go without watering for a week or more. The following are examples:

Plants which will grow in hot and dry conditions

Common name	Scientific name
Aeonium	*Aeonium arboreum*
Tiger Aloe	*Aloe varigata*
Zebra Plant	*Cryptanthus zonatus* var. zebrinus
Echeveria	*Echeveria gigantea*
Mother of Thousands	*Kalanchoe daigremontiana*
Air Plants	*Kalanchoe pinnata*
Lamb's Ear Kalanchoe	*Kalanchoe tomentosa*
Sedum	*Sedum* sp.

Proper ventilation is necessary for good plant growth. In most homes, ample fresh air is provided. However, guard against escaping gases from gas appliances or furnaces.

Humidity

Most plants require a higher humidity than that of the average home. Any means of increasing humidity will be beneficial to your plants. Today many heating systems are provided with humidifiers, which should be kept filled with water. Sprinkling or syringing plants with water on bright days may be helpful in raising the humidity around the leaves. Fittonia *(Fittonia verschaffelti)*, Baby's Tears *(Helxine soleiroli)*, and Strawberry Plant *(Saxifraga sarmentosa)* will tolerate high humidity conditions. Growing plants together or setting them on a tray of gravel with moisture in the tray is also helpful in raising humidity.

Watering

Improper watering is the cause of most house plant problems. Both under- and over-watering can cause leaves to yellow and fall. Check plants daily to establish a schedule. If they need watering (soil dry ¼ inch down and tapped pot sounds hollow), add water until moisture drips out of the drainage hole of the pot. Wait a few minutes and water the plant again until moisture drips out of the drainage hole. Be sure to discard drainage water. Do not allow the bottom portion of the pots or plants to stand in water.

With small plants, weight is a good indicator of when water is needed. Dryer plants feel lighter than those with moist soil. Some dedicated gardeners even go so far as to weigh the pots and plants on a small scale.

If you prefer, water from the bottom. Place the plant in a saucer of water until the top of the soil is moist. Then remove the plant and let excess moisture drain away. Never keep ordinary house plants standing in water continuously.

A well-drained soil mixture is essential for ease of watering. Heavy soil mixes hold too much water and often cause the plant to rot at the crown.

When watering, the water should be visible on the surface for not more than a few seconds. If it tends to stand on the surface, add perlite or sand to the soil to improve drainage.

Note: Water all plants from the top once a month to prevent mineral or salts build-up, and be sure to water any plant before it wilts. A build up of white or brown crusty material on the rim or soil of the pot indicates salts accumulation.

Fertilizing

Water your house plants with a dilute fertilizer solution, especially during the rapid summer growing season. Prepare a solution by mixing one teaspoon of soluble fertilizer in 1 gallon of water. Such analyses as 20-20-20, 5-10-5, 4-12-4, or 7-7-7 may be used. Apply once a month during the growing season. Often a grower will purchase a commercially-prepared soluble fertilizer. He should then use it according to the directions on the container.

The new slow release fertilizers, such as Osmocote, save fertilization time. Apply 1-2 teaspoons to each six-inch pot every three months and larger amounts to larger pots. Incorporate into the soil. Each time you water, some fertilizer is released.

Repotting

It is best to purchase a prepared soil mixture free of weeds, insects and disease organisms. If you mix your own, sterilize the soil for 20-30 minutes in a 180°F oven.

In the spring when new growth starts, turn each of your plants upside down, tap the edge of the pot, and remove the plant. If the roots are in a solid mass, remove part of the old soil and shift the plant to a pot (with a drainage hole) 1 or 2 inches larger in diameter. Fast-growing plants may need an even larger pot. Add new soil. For most plants, use 1/3 sphagnum peat moss, 1/3 garden soil (loam) and 1/3 sand. For cactus, use ½ quartz sand and ½ garden soil. After adding soil, water as usual. You may need to check and repot fast-growing plants more often than once a year. Usually you will not need to water so often for a few months after repotting.

When a house plant has reached a desirable size, then do not repot it. Instead, remove some of the soil at the top of the pot at least once a year and replace with fresh soil.

Additional care

Most plants, except those with hairy leaves, respond to an occasional bath. Syringing the plants weekly with a fine spray of clean water removes accumulated dust and keeps the stomates (pores) open. For small plants, place in the sink or shower. During warm, summer rains house plants can be placed out-of-doors.

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Some broad-leaved plants, such as palms, may be cleaned by rubbing with a soft cloth. Never use an oiled cloth. However, special leaf waxes available in many florist shops may be used on glossy-leafed plants without causing any apparent harm.

Use a fine, soft brush, such as camel's hair to clean hairy-leafed plants. Never use leaf wax on these plants.

Climbing plants may be trained to a totem for ease of care as well as aesthetic effect.

Summer care

Many house plants can be invigorated by growing them outside during the summer. Remove all dead leaves and prune where necessary. Place the plants in a location suitable to their light requirement, e.g. subdued daylight plants should be placed on a shady porch.

For minimum summer care, dig a hole, put gravel or cinders in the bottom, and set the pot so the top is at the original soil line. Mulch with peat moss, and water. Usually these plants need watering more often than when indoors.

During the summer, lift or twist the pot at least every month to prevent roots from growing through the drainage hole in the pots.

Lift the plants with their pots before they are endangered by autumn frosts and repot if necessary. Spray to remove any insect or disease infestations before returning indoors. For most plants, Malathion (2 teaspoons of a 57% liquid concentrate in one gallon of water) will control many incoming insect pests. The best procedure is to set the plants outside on a warm day and thoroughly wet the plants, soil, and pots. Then return them indoors the following day. For very small plants, turning the entire plant and pot upside down and giving a total immersion (quick dip) is satisfactory. This is especially good for controlling crawling insects such as mites.

Before you vacation, water all house plants well. Either have a "baby-sitter" water your indoor plants or move them out-of-doors as suggested. However, drying out can be delayed for a while if pots are sunk in moist vermiculite or peat moss and kept in a cool spot away from direct sun.

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Plants requiring intermediate light intensity (100-200 foot candles).

Location usually 4 to 8 feet from windows—average well lighted area.

Fern Asparagus	*Asparagus setaceus*
Sprengeri Asparagus	*Asparagus densiflorus* 'sprengeri'
Rex Begonia, Iron Cross Begonia	*Begonia sp.*
Caladium	*Caladium hortulanum*
Peacock Plant	*Calathea makoyana*
Areca Palm	*Chrysalidocarpus lutescens*
Umbrella Plant	*Cyperus alternifolius*
Dumbcane	*Dieffenbachia amoena*
Dumbcane	*Dieffenbachia exotica*
False Aralia	*Dizygotheca elegantissima*
Dracaena	*Dracaena deremensis*
Warneckii Dracaena	*Dracaena deremensis* 'Warneckii'
Corn Plant	*Dracaena fragrans* 'Massangeana'
Gold Dust Plant	*Dracaena godseffiana*
Red Edge Dracaena	*Dracaena marginata*
Dracaena	*Dracaena sanderiana*
Episcia	*Episcia cupreata*
Weeping Fig	*Ficus benjamina*
Rubber Plant	*Ficus elastica* 'decora'
Fiddle-leaf Fig	*Ficus lyrata*
Wax Plant	*Hoya carnosa*
Nerve or Prayer Plant	*Maranta leuconeura* 'kerchoveana'
Cut-leaf Philodendron	*Monstera deliciosa*
Boston Fern	*Nephrolepis exaltata* 'bostoniensis'
Peperomia	*Peperomia obtusifolia*
Philodendron	*Philodendron domesticum*
Heart-leaf Philodendron	*Philodendron oxycardium*
Fiddle-leaf Philodendron	*Philodendron panduraeforme*
Aluminum Plant	*Pilea cardierei*
Staghorn Fern	*Platycerium bifucatum*
Pteris Fern	*Pteris ensiformis*
Pothos	*Epipremnum aureum*
Schefflera	*Brassaia actinophylla*
Silver Pothos	*Scindapsus pictus*
Asian Umbrella Tree	*Schefflera arboricola*
Spathiphyllum	*Spathiphyllum clevelandii*
Nepthytis	*Syngonium podophyllum* 'Emerald Green'
Nepthytis	*Syngonium podophyllum* 'Green Gold'
Christmas Cactus	*Zygocactus truncatus*

Plants which will grow in low light intensity (50-100 foot candles).

Location usually more than 8 feet from windows, no direct light—dull hallways.

Commutatum	*Aglaonema commutatum*
Pewter Plant	*Aglaonema roebelinii*
Chinese Evergreen	*Aglaonema modestum*
Birds-nest Fern	*Asplenium nidus*
Cast-iron Plant	*Aspidistra elatior*
Bamboo Palm	*Chamaedora erumpens*
Spider Plant	*Chlorophytum comosum*
Parlor Palm	*Chamaedora elegans*
Jade Plant	*Crassula argentea*
House Holly-Fern	*Cyrtomium falcatum*
English Ivy	*Hedera helix*
Tricolor Bromeliad	*Neoregelia carolinae*
Self-heading Philodendron	*Philodendron wendlandii*
Climbing Philodendron	*Philodendron* 'Red Princess'
Sea Teak	*Podocarpus macrophylla* 'Maki'
Snake Plant	*Sansevieria trifasciata* 'Laurentii'
Birdnest Sansevieria	*Sansevieria trifasciata* 'Hahnii'
Vriesia	*Vriesia carinata*

Plants requiring high light intensity (over 200 foot candles).

Location usually brightly lighted offices—areas within 4 feet of large south, east, or west facing windows.

Common name	Scientific name
Air Plant	*Aechmea fasciata*
Zebra Plant	*Aphelandra squarrosa*
Norfolk-island Pine	*Araucaria excelsa*
Gold Dust Tree	*Aucuba japonica* 'variegata'
Shrimp Plant	*Beloperone guttata*
Croton	*Codiaeum variegatum*
Coffee	*Coffea arabica*
Ti Plant	*Cordyline terminalis*
Crown-of-thorns	*Euphorbia splendens*
Fatshedera	*Fatshedera lizei*
Velvet Plant	*Gynura sarmentosa*
Velvet-leaf Philodendron	*Philodendron micans*
Japanese Pittosporum	*Pittosporum tobira* 'variegata'
African Violet	*Saintpaulia ionantha*

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HO-99

GROWING ANNUAL FLOWERS

John A. Wott

Most home gardeners consider annuals (plants which complete their growing cycle within one growing season) among their favorites. Quite versatile, annuals are suited to a variety of uses and conditions. They are inexpensive; available in many shapes, sizes and colors; and most produce abundant blooms. Today, the petunia, marigold and zinnia are most popular, but there are many other annuals which are both practical and easy to grow.

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Uses

Annual flowers are useful in many ways. They may be planted among perennials in a perennial garden, among foundation plantings as a low-growing hedge or border, or as accents in planters, boxes or urns. For landscaping, annuals provide a mass of color in contrast to the dark foilage of ornamental shrubs, and are often planted to fill in newly-established shrub beds and to overplant bulb beds to provide color after spring-flowering bulbs have faded. Many annuals can also be used for fresh-cut flowers and some for dried, winter arrangements.

Some annuals are not well-adapted to the summer heat (e. g. sweetpea), whereas others will bloom well all summer long. Some dwarf forms, the marigold and salvia, for example, will flower early while the giant forms flower later. Selection according to a desirable height is also possible in such annuals as the snapdragon and zinnia.

Location

Most flowering annuals grow best in the full sun and in a well-drained garden soil. Plants grown in the shade are spindly and produce fewer flowers. Those placed in wet, heavy soils also grow poorly. Before selecting a definite garden site, check for drainage. Dig a hole 10 inches deep and fill it with water. If the water drains away in 8-10 hours the permeability of the soil is acceptable for growing annuals.

Also check the sowing recommendations. Some seeds, such as poppy and sweetpea, should be sown in their permanent location, whereas most annuals can be transplanted.

Soil preparation

Organic materials such as sphagnum peat moss, leaf mold, compost and rotted manure should be applied early in the spring. Spade or rototill the soil to a depth of 8-10 inches, being sure to incorporate the organic materials thoroughly. Work the soil several weeks before planting in the spring in areas previously used for annuals. If annuals have not been grown in the area, the organic matter should be worked into the soil the preceding fall.

If annuals are to be started from seed, the bed must be level and the area raked smooth after the final soil preparation. All stones, clods, and old plant refuse should be removed.

Little soil preparation is necessary for annuals planted in bulb or shrub beds. These beds should have been well-prepared when they were established. Still, a light cultivation along with some additional organic matter is often beneficial for getting annuals established in these areas.

Annuals for container growing should be grown in new soil each year. A potting mixture of garden loam, sphagnum peat moss, and vermiculite or perlite (1:1:1 by volume) is satisfactory. However, drainage holes in the bottom of the container or 2 inches of crushed rock, flower chips or gravel are necessary for good drainage.

Fertilizer

Fertilizer should be applied when the soil is prepared. Use 1 to 2 pounds of 5-10-5 or similar analysis fertilizer per 100 square feet of bed area. If the soil fertility is low, additional applications may be necessary throughout the growing season. Usually ½-1 pound of 5-10-5 per 100 square feet every month to six weeks will suffice. Do not let dry or concentrated liquid fertilizer fall on the foliage or flowers. Water thoroughly after applying fertilizer.

Seed

Many annuals can be started from seed after the soil warms up in the spring (usually above 60° F). However, it's best to use hotbeds or cold frames for earlier starts. Start the seed indoors no sooner than 8 weeks before the average date for the last killing frost in your area. Care must be taken so that plants are not ready for transplanting out-of-doors before the weather is settled. However, seed of babies'-breath, cornflower, gaillardia, globe amaranth, phlox, poppy, salpiglossis, cleome, stock, strawflower, summer cypress, sweet alyssum and sweet pea may be sown in the early spring as soon as the soil can be worked.

Select seed from reputable catalogs or garden centers. Purchase only recommended varieties. Many of the new annuals are F_1 hybrids. Since seed saved from these plants often results in plants that do not resemble the parents in color, size or habit of growth, seed should not be saved for planting the following year.

Sowing

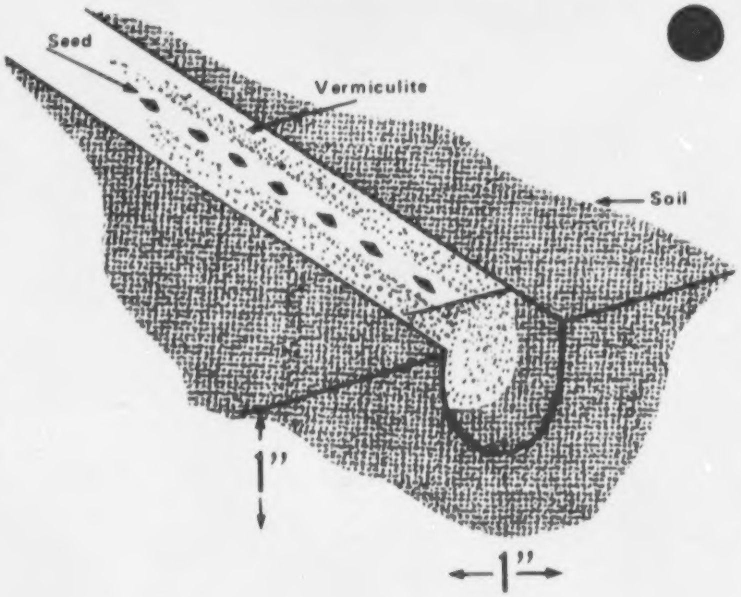
After the seedbed has been smoothed, use a rounded stick or hoe handle to make a furrow the recommended sowing depth. Cover with a fine layer of soil, and then water.

In heavy soil make the furrow larger, or about 1 inch wide and 1 inch deep (Figure 1). Fill the furrow with fine vermiculite or perlite and sprinkle with water. Then make another shallow furrow in the vermiculite and sow the seed the recommended depth. Cover the seed with a layer of the vermiculite or perlite, and use a light mist to water the area thoroughly.

To slow evaporation, the area can be watered lightly every 3-4 hours on bright sunny days, or the soil can be covered with newspapers or sheets of plastic supported on sticks 1 to 2 inches above the ground. Remove the paper or plastic as soon as the seedlings appear.

All plants should be properly labeled for later ease of identification.

Figure 1. Recommended planting procedure



Thinning

When the seedlings have developed two true leaves, they should be thinned or transplanted to their permanent location. The recommended spacing given in the accompanying chart allows for each individual plant to recei enough light, water, nutrients and air for proper growth a development. Seedlings produced in vermiculite furrows are very easily transplanted to other locations.

Transplanting

Seedlings started in cold frames, hotbeds, home greenhouses, or purchased as started plants are advantageous for many homeowners. These plants are easily transplanted and are usually in bloom when planted. Thus the plants provide a colorful array of bloom from early spring until the first killing frost of the fall.

Transplant only after the danger of spring frost has passed – May 1, southern Indiana; May 15, central; May 20-30, northern. Seedlings started in trays or flats are removed by slicing downward through the soil with a knife between the plants. Carefully lift out each plant with the intact block of soil. Plants started in fiber, plastic or clay pots should be removed from their containers before planting. Plants grown in peat pots can be transplanted intact, since the pots will decompose.

Set the plants only slightly deeper than they were growing in the original container and at their recommended spacing. When transplanting plants in peat or fiber pots, remove the portion of the pot above the soil surface as a safeguard against trapping excessive water around the plants. Occasionally, the bottom portion may need to be removed to improve drainage.

Press the soil firmly around the plant. Water with a diluted fertilizer solution, such as one tablespoon of hi phosphate fertilizer (10-52-17) or similar analysis) in gallon of water.

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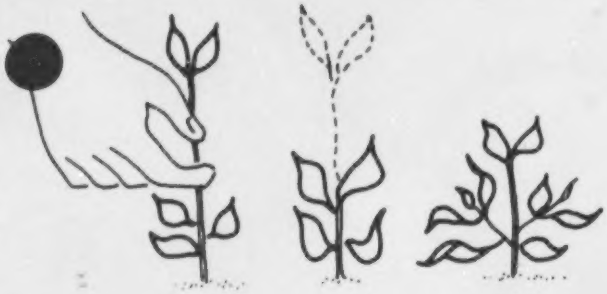
Figure 2. Most annuals respond to an early "pinch".



Mulching

Mulching flower beds will help to conserve moisture, reduce annual weed populations, reduce cultivation time, preserve soil aeration and drainage, and improve the appearance of the bed.

Apply the mulch when the soil is moist and the temperature above 60°F. Apply 2-3 inches of mulch, such as sphagnum peat moss, partially-rotted ground or crushed corn cobs, pine needles, compost, wood chips, granite chips, shredded bark or a layer of black plastic.

Mulches of black plastic are becoming more popular. Start by spreading the plastic over the surface of the prepared soil. Cut large X-marks approximately 4 inches long where the plants are to be set and place the plants through them. The plants will soon cover the mulch. Your garden will remain free of weeds and be less affected by drought during the summer.

* * *

Planting and care of selected bedding plants usually grown as annuals

Plant	Exposure	Plant spacing (Inches)
Coleus	Sun Semi-shade	10-12
Dahlia	Full sun	12-14
Geranium	Full sun Semi-shade	12-18
Impatiens	Full sun Semi-shade	10-12
Pansy	Full sun Semi-shade	6-8
Petunia	Full sun	12-14
Salvia	Full sun	8-12
Snapdragon	Full sun	6-10
Verbena	Full sun	18-24
Zinnia	Full sun	8-12

Pinching

Most annuals respond to pinching (Figure 2). Plants which are pinched will produce more flowers during the growing season, even though the first bloom often is lost. Usually the top inch or two is removed from the growing tip, leaving 3 or 4 leaves. Started plants often have been pinched by the grower, so check the plants when you purchase them.

* * *

Cultivation

Light cultivation should be carried out early in the season to break the crust that forms on the soil surface. After the plants are growing vigorously, stop cultivating, since cultivation at that time will damage some of the shallow feeder roots. Any other weeds can be hand-pulled throughout the remainder of the season.

Watering

Watering is important for the continual growth of the plants. Generally 1 inch of water each week applied in one watering is required. A sprinkler or soaker hose is more satisfactory than watering with a hand-held hose. Allow the water to penetrate down into the root zone at least 6-8 inches. Soaker hoses are probably most efficient, since there is little water runoff and evaporation and soil compaction is slight.

Flower removal

Annuals are noted for the number of blooms produced during the growing season. However, if old, faded blooms are removed every 5 to 7 days, the plants will be stimulated toward more flower production. Ageratum, calendula, cosmos, marigold, pansy, rudbeckia, scabiosa, and zinnia respond especially well. Long stems of ageratum, fiberous-rooted begonia, annual phlox, bells of Ireland, coleus, pansy, petunia and verbena can be pruned to keep the plants compact.

Annuals desired for cut flowers should be grown in a separate area, usually in rows where they can be fertilized and staked.

Additional information

For additional information, consult the following publications available at your County Extension Office or Mailing Room, Agricultural Administration Building, Purdue University, Lafayette, Indiana 47907.

BP-1-4	"Powdery Mildew of Garden Flowers"
BP-1-9	"Aster Wilt and Yellows"
E-70	"Insect Pests of the Flower Garden"
HO-72-2	"Suggested List of Annual Flowering Plants"

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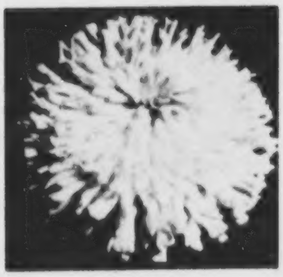

Planting and care of selected garden annuals sown as seeds

Plant	Planting Time	Exposure	Germination Time (Days)	Plant Spacing (Inches)
Ageratum	Late spring	Full sun	5	10-12
Amaranthus	Late spring	Semi-shade	10	10-12
Aster	Late spring	Full sun	8	12-14
Babies'-breath	Early spring	Full sun	10	10-12
Bachelor's Button	Early spring	Full sun	10	8-10
Calendula	Early spring	Full sun	10	8-10
Calliopsis	Late spring	Full sun	8	10-14
China Aster	Late spring	Shade or sun	8	10-12
Cockscomb	Late spring	Full sun	10	10-12
Cornflower	Early spring	Partial shade	10	12-14
Cosmos	Late spring	Full sun	5	10-12
Forget-me-not	Late spring	Full sun Semi-shade	8	10-12
Four-o'clock	Late spring	Full sun	5	12-14
Gaillardia	Early-late spring	Full sun	20	10-12
Lupine	Early spring	Full sun	20	6-8
Marigold	Late spring	Full sun	5	10-14
Morning Glory	Late spring	Full sun	5	24-36
Nasturtium	Late spring	Full sun	8	8-12
Petunia	Early spring	Full sun	10	12-14
Phlox	Early spring	Full sun	10	6-8
Portulaca	Late spring	Full sun	10	10-12
Rudbeckia	Late spring	Full sun Semi-shade	20	10-14
Salpiglossis	Early spring	Full sun	15	10-12
Scabiosa	Early-late spring	Full sun	10	12-14
Sweet Alyssum	Early spring	Full sun	5	10-12
Spider Plant	Early spring	Full sun	10	12-14
Strawflower	Early spring	Full sun	5	10-12
Sunflower	Late spring	Full sun	5	12-14
Sweetpea	Early spring	Full sun	15	6-8
Zinnia	Late spring	Full sun	5	8-12

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Publication E-61
December 1977

HOW TO CONTROL TURF INSECTS

Donald L. Schuder, Extension Entomologist

Many insects live in blue grass turf, but only a few are important enough to require control measures. Following are those that may seriously injure or disfigure lawns, golf greens and other turf areas.

Grubs: Grubs are the larvae of June beetles or the Japanese beetle. They are fat, white with brown heads, have prominent legs and curved bodies measuring up to one inch long. Grubs eat the roots of grasses, causing the turf to turn brown and die. Most species require 3 years to reach maturity, but some, including the Japanese beetle, have a one-year cycle. If turf shows brown or dead areas, examine it first for grubs. Grub-infested turf will be loose and can easily be pulled back to expose the insects.

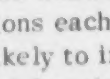
Sod Webworms: The first signs of sod webworm damage are areas of unevenly cropped grass. Soon, large areas may turn brown and die. Close examination will show that the blades have been eaten away, with the bits of chewed foliage between the grass stems. The worms are about 3/4 inch long, slender, cream or light brown in color with dark spots on their backs. They live in silken tubes at the base of the plants. Sod webworms produce two or three generations each year; therefore, the damage is likely to increase as the summer wears on. Adult webworms are small, cream-colored "millers" that flit about over the lawn and cluster around lights in the evening. They have a noticeable snout projecting in front of the head and fold their wings tightly against the body when resting. Birds picking at lawns may indicate the presence of webworms.

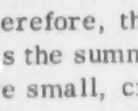
Proper diagnosis is important because certain plant diseases may also create turf conditions that are easily confused with sod webworm damage.

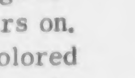
Ants: The most serious lawn ants are the "mound builders," that disfigure or destroy increasingly large areas of turf. Ants do not eat grass, but they do interfere with its growth by loosening and honeycombing the soil and by throwing up mounds of earth. Ask for publication E-22.

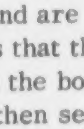
Chiggers: These are tiny mites sometimes found in grass during the summer. They do not damage turf but annoy people. Heavy infestations are most likely to occur in tall unmowed grass, vacant lots and other unkept areas. Ask for publication E-34.

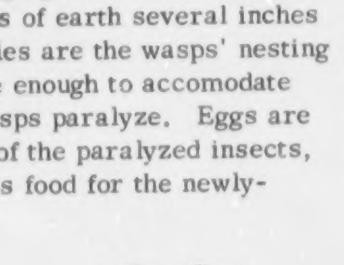
Digger Wasps: Large wasps, especially the yellow and black "cicada killer," disfigure lawns by digging holes in the soil and throwing up mounds of earth several inches across. These holes are the wasps' nesting sites and are large enough to accomodate insects that the wasps paralyze. Eggs are laid on the bodies of the paralyzed insects, which then serve as food for the newly-


Grub


Webworm


Ant


Chigger


Digger wasp

hatched young. Digger wasps are not known to sting or otherwise injure humans, unless handled.

WHAT TO USE

Use one of the insecticides listed in Table 1 below. Comparative effectiveness against different insects is shown so that the user can select a material that best fits his needs.

HOW TO APPLY

Apply granules with a lawn fertilizer spreader. For spraying home lawns, use one of the insecticides designated as EC or WP in Table 1. Mix the required amount with 3 gallons of water and apply evenly to 1000 square feet.

WHEN AND WHERE TO APPLY

1. White grubs. Apply in early spring or when grubs appear and water into the soil. Chlordane will give protection for 3 or more years.

2. Sod webworms. Apply between May 15 and June 15. Diazinon needs to be watered in. Dylox is effective with or without watering in. Removing grass clippings and thatch helps prevent damage.

3. Ants. Apply when needed and water in. Mound building ants can be spot treated.

4. Chiggers. Apply just prior to start of chigger season. Allow chemical to remain on the surface a day or two before watering in.

5. Digger wasps. Treat infested area and inject some of the material directly into burrows. Do not water in until wasps disappear.

PRECAUTIONS

Follow label directions. Do not allow children or pets on treated turf until insecticide has been watered in and has dried.

Table 1. Insecticides for the control of turf insects

Insecticide and Formulation		Use per 1000 sq. feet	Use per one acre	Comparative effectiveness against: Web-worms	Grubs	Ants	Chig-gers	Digger Wasps
Chlordane	45% EC	1/2 pt.	2 1/2 gals.	P	E	E	G	
Chlordane	10% G	2 1/2 lbs.	100 lbs.	P	E	E	F	
Diazinon	25% EC	1/2 pt.	2 2/3 gals.	G	G	F	G	F
Diazinon	2% G	5 lbs.	215 lbs.	E	G	F	G	F
Trichlorfon*	50% WP	1/4 lb.	11 lbs.	G	G			
Trichlorfon*	2% G	6.5 lbs.	275 lbs.	E	P			
Chlorpyrifos**	2 E	1 1/2 oz.	2 qts.	E	G	G		
Chlorpyrifos**	4 E	3/4 oz.	1 qt.	E	G	G		
Ethion	12% EC	2 pts.	11 gals.	G				
Ethion	5% G	1/4 lb	11 lbs.	G				
Propoxur	1.5 EC	11 ozs.	60 lbs.	G		G		
Propoxur	5% G	2 1/2 lbs.	100 lbs.	G		G		
Propoxur	70% WP	2 3/4 ozs.	7 1/2 lbs.	G		G		

*Trichlorfon = Dylox; Chlorpyrifos = Dursban; Propoxur = Baygon; EC = emulsifiable concentrate; G = granules; WP = wettable powder; E = excellent; G = good; F = fair; and P = poor

** Rate should be increased 2-4 times for Japanese Beetle grubs.

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West Lafayette, Indiana 47907

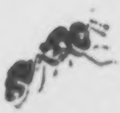
Publication E-70
October 1976

INSECT PESTS OF THE FLOWER GARDEN

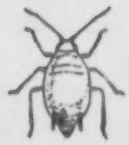
Donald L. Schuder, Extension Entomologist

Many of the insecticides suggested here are contained in various commercial "all-purpose" rose and flower dusts, available at most garden centers. Always use insecticides wisely and safely by following directions on the containers.

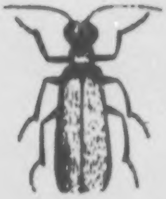
Abbreviations: WP = wettable powder; EC = emulsifiable concentrate.



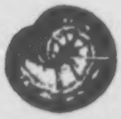
ANTS: Do not feed on plants but loosen soil around roots; also care for aphids and feed on "honeydew" secreted by aphids or on sap exuded by some plant buds. Control: Dust soil and plants with chlordane 5% dust*, OR spray with chlordane as for blister beetles, OR scatter chlordane granules.* Diazinon (Spectracide) according to label directions.



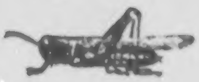
APHIDS: Small, soft-bodied insects of pinhead size, that suck plant juices. Control: Dust with malathion 4% dust, OR spray with malathion 57% EC using 2 teaspoons per gallon of water OR spray with Diazinon according to label. Apply dimethoate (Cygon, DeFend) according to package directions. As a preventive, spread 10.7 ozs. of Di-Syston 15% granules over each 150 ft. of row or furrow, and water in. DI-SYSTON IS HIGHLY TOXIC TO HUMANS, SO FOLLOW DIRECTIONS ON PACKAGE.



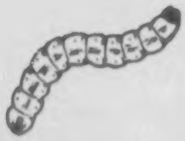
BLISTER BEETLES: Large, long-legged, active insects that strip foliage from plants. Control: Dust with chlordane 5% dust*, OR spray with chlordane 40% WP using 4 teaspoons per gallon of water, OR spray with chlordane 45% EC using 4 teaspoons per gallon of water*, OR dust or spray with carbaryl (Sevin) as for leaf beetles, OR apply methoxychlor according to label directions.



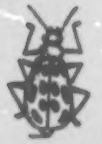
CUTWORMS: Cut off plants at night and spend the day curled up in the soil. Control: Spray or dust plants and surrounding soil with Dylox or Diazinon or chlordane* as for blister beetles OR with carbaryl (Sevin) as for leaf beetles. Protect transplants with paper or metal collars around the stems.



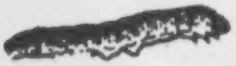
GRASSHOPPERS: Eat many kinds of plants. Control: Spray or dust garden and surrounding grassy and weedy areas with chlordane* as for blister beetles OR with carbaryl (Sevin) as for leaf beetles.



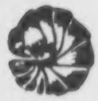
IRIS BORERS: Large borers that feed in the rhizomes. Control: When new growth is 5-6 inches tall, apply dimethoate (Cygon, DeFend) according to manufacturer's directions. Prevent reinfestation by transplanting rhizomes every 3 or 4 years and discarding borer-infested ones.



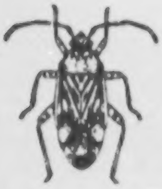
LEAF BEETLES: Chewing insects that eat foliage and flowers or make tiny holes in leaves. Control: Spray or dust with carbaryl (Sevin) 5% dust OR spray with carbaryl 50% WP using 6 teaspoons per gallon of water. Malathion spray or dust as suggested for aphids is also effective.

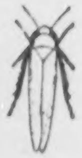


LEAF-FEEDING CATERPILLARS: Many kinds eat foliage, bore into flower buds or roll leaves. Control: Dust or spray with carbaryl (Sevin) as for leaf beetles OR with malathion as for aphids, OR with Dylox according to directions on the label.

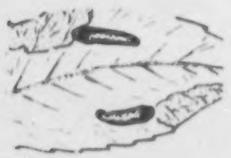


PILLBUGS: Curl up in a ball when disturbed, and feed on decaying organic matter as well as plants. Control: Remove boards and trash under which bugs hide. Spray or dust with chlordane* as for blister beetles, OR with carbaryl (Sevin) as for leaf beetles, OR spray Zectran** per label.

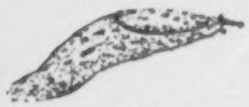




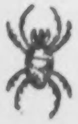
PLANT BUGS AND LEAFHOPPERS: Active insects that suck plant juices and cause flowers or foliage to become spotted and blasted. Control: Spray or dust with carbaryl (Sevin) as for leaf beetles OR with malathion as for aphids. Di-Syston applied to the soil as for aphids or dimethoate (Cygon, DeFend) according to package directions are also effective.



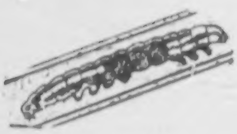
ROSE SLUGS: Small slugs (sawfly larvae) that feed on the undersides of rose leaves, skeletonizing and causing them to turn brown. Control: Dust with rotenone-sulfur dust, OR spray or dust with malathion as for aphids.



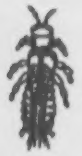
SLUGS: Large, soft-bodied creatures that leave a slimy trail. Control: Scatter a metaldehyde OR Mesurol slug and snail bait according to package directions, or spray with Zectran** according to label directions.



SPIDER MITES (Red Spider): Tiny mites that cause foliage to turn grey and die. Control: Spray with Kelthane, Pentac, Tedion, Ovex, Plictran or other miticide according to package directions, OR spray or dust with malathion as for aphids. As a preventive, spread Di-Syston as for aphids.



STALK BORERS: Found in stems of plants. Control: Burn dead plant debris in the fall. To prevent infestations, dust growing plant frequently with carbaryl (Sevin) 5% dust. Borers can also be removed from stalks by slitting and pinching the stems.



THRIPS: Tiny, active insects that cause foliage to become spotted and flowers to be deformed; a serious pest of gladiolus. Control: Dust gladiolus corms in fall with 3 or 4% malathion dust. Dust or spray plants in field with lindane or Zectran** according to package directions. Di-Syston or dimethoate as for plant bugs is also effective.

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* May be used unless a formal suspension or cancellation of use notice has been issued.

** Manufacturer is suspending production. Use until supply is exhausted.

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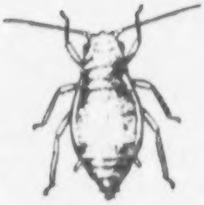
10/76-5M

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, IN. Issued in furtherance of the Acts of May 8 and June 30, 1914.

Purdue University
Cooperative Extension Service
Department of Entomology

Mimeo E-65
May, 1967

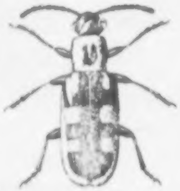
VEGETABLE INSECT IDENTIFICATION



APHID

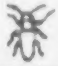
Many genera and species
Family Aphididae

Actual size



ASPARAGUS BEETLE

Crioceris asparagi (Linnaeus)
Family Chrysomelidae



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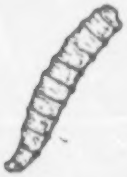
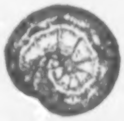


CABBAGE MAGGOT

Hylemya brassicae (Bouche)
Family Anthomyiidae

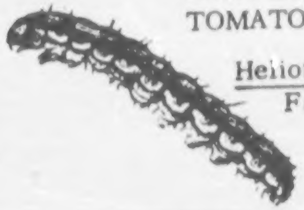
Actual size



CUTWORM

Many genera and species
Family Noctuidae

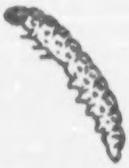
Shown actual size



CORN EARWORM (or) TOMATO FRUITWORM

Heliothis zea (Boddie)
Family Noctuidae

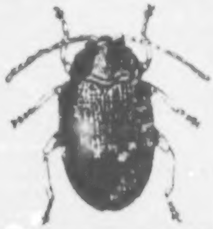
Shown actual size



EUROPEAN CORN BORER

Ostrinia nubilalis (Hubner)
Family Pyraustidae

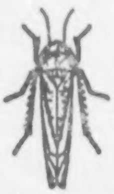
Shown actual size



FLEA BEETLE

Many genera and species
Family Chrysomelidae

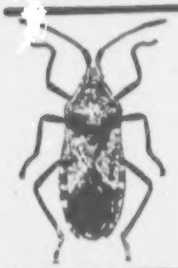
Actual size



LEAFHOPPER

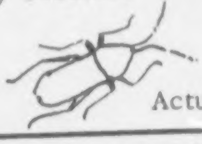
Many genera and species
Family Cicadellidae

Actual size



SQUASH BUG

Anasta tristis (DeGeer)
Family Coreidae



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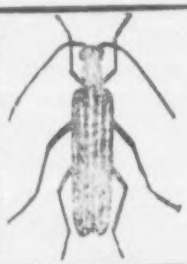
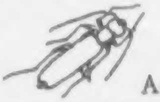


STRIPED BLISTER BEETLE

Epicauta vittata (Fabricius)
Family Meloidae



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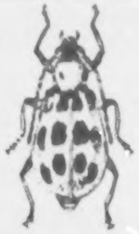
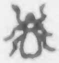
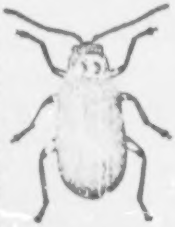


SPOTTED CUCUMBER BEETLE

Diabrotica undecimpunctata howardi (Barber)
Family Chrysomelidae

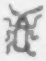


Actual size



STRIPED CUCUMBER BEETLE

Acalymma vittata (Fabricius)
Family Chrysomelidae



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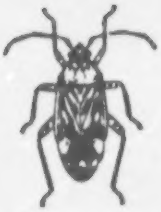
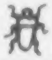
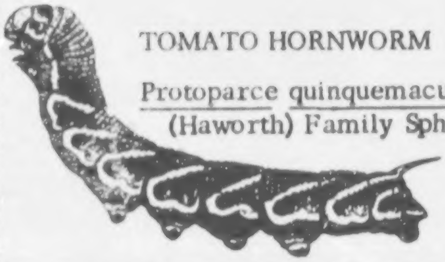


TARNISHED PLANT BUG

Lygus lineolaris (Palisot de Beauvois)
Family Miridae

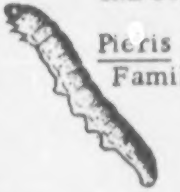
 Actual size



TOMATO HORNWORM

Protoparce quinquemaculata (Haworth) Family Sphingidae

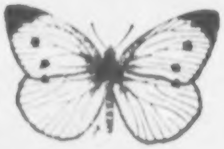
Shown actual size



IMPORTED CABBAGEWORM

Pieris rapae (Linnaeus)
Family Pieridae

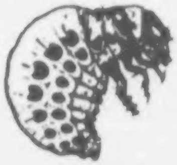
Shown actual size



CABBAGE BUTTERFLY

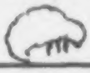
Pieris rapae (Linnaeus)
Family Pieridae

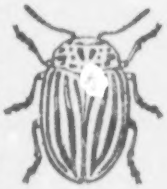
2/3 actual size



COLORADO POTATO BEETLE LARVA

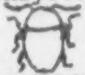
Leptinotarsus decemlineata (Say)
Family Chrysomelidae

 Actual size



COLORADO POTATO BEETLE

Leptinotarsus decemlineata (Say)
Family Chrysomelidae

 Actual size

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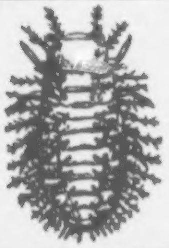
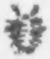
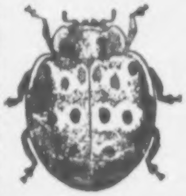


MEXICAN BEAN BEETLE LARVA

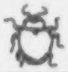
Epilachna varivestis (Mulsant)
Family Coccinellidae

 Actual size



MEXICAN BEAN BEETLE

Epilachna varivestis (Mulsant)
Family Coccinellidae

 Actual size

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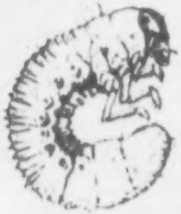
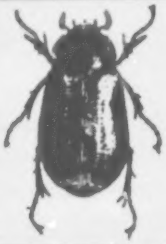


WHITE GRUB

Many genera and species
Family Scarabaeidae

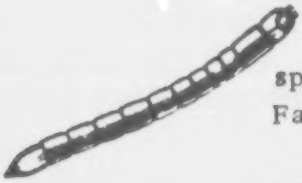
Shown actual size



JUNE BEETLE

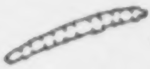
Many genera and species
Family Scarabeidae

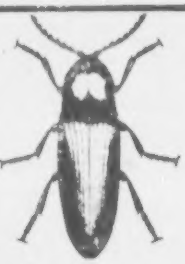
Shown actual size



WIREWORM

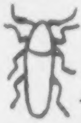
Many genera and species
Family Elateridae

 Actual size



CLICK BEETLE

Many genera and species
Family Elateridae

 Actual size

662

4/62

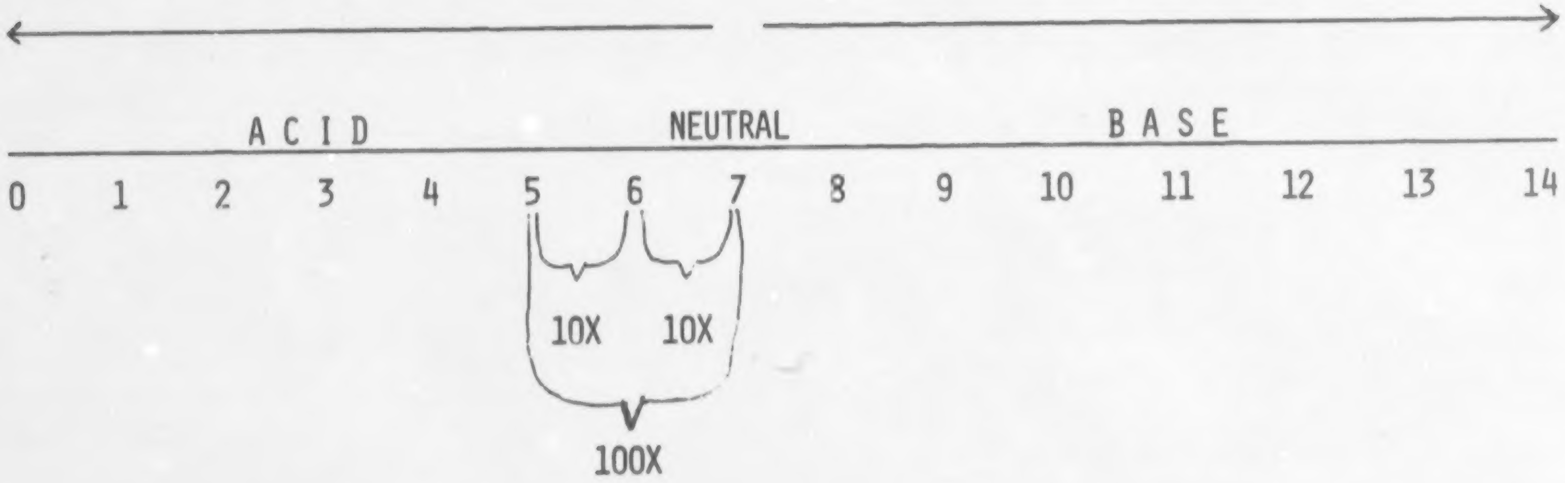
Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 3[illegible], 1914.

FERTILIZER ANALYSIS

N		P_2O_5		K_2O
10	-	20	-	10

INGREDIENTS	NAME	NUTRIENT CONTAINED	PERCENT OF AVAILABLE NUTRIENT
N	Nitrogen	Nitrogen	10.0%
P_2O_5	Phosphoric Acid	Phosphorus	8.7%
K_2O	Soluble Potash	Potassium	8.3%

pH SCALE


ACID
NEUTRAL
BASE
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
10X
10X
100X

SAFETY FIRST

ALL CHEMICALS SHOULD BE REGARDED AS HAZARDOUS--SOME MORE THAN OTHERS. READ THE LABEL AND TAKE ALL PRESCRIBED PRECAUTIONS.

1. STORE CHEMICALS UNDER LOCK AND KEY OUT OF REACH OF CHILDREN, PETS, LIVESTOCK AND AWAY FROM FOOD AND FEED.
2. KEEP CHEMICALS IN THEIR ORIGINAL CONTAINERS WITH LABELS INTACT.
3. GET RID OF UNUSED CHEMICALS AND EMPTY CONTAINERS IN SUCH A WAY THAT THEY ARE NO LONGER HAZARDOUS.
4. DO NOT EAT OR SMOKE WHEN APPLYING CHEMICALS.
5. WEAR PROTECTIVE CLOTHING AND MASKS WHEN DIRECTED ON LABEL.
6. BATHE AND CHANGE TO CLEAN CLOTHES RIGHT AFTER APPLYING HERBICIDES; WASH CLOTHING BEFORE RE-WEARING.
7. IF CHEMICALS ARE SPILLED ON THE SKIN, WASH OFF IMMEDIATELY.
8. IF CHEMICALS ARE SPILLED ON CLOTHING, REMOVE IMMEDIATELY AND WASH BEFORE RE-WEARING.
9. WHEN APPLYING CHEMICALS, AVOID CONTAMINATING FOOD AND WATER SUPPLIES.

METHODS OF PEST CONTROL

NATURAL CONTROL

MECHANICAL CONTROL

QUARANTINE METHOD

BIOLOGICAL CONTROL

CHEMICAL CONTROL

LESSON 6: LANDSCAPE DESIGN

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Define in writing the term landscape design.
2. Define the varying responsibilities of landscape architects, landscape designers, and specialists in landscape management.
3. List five reasons for home landscaping.
4. Describe the basic design principles utilized in landscape design.
5. List the three main landscape areas commonly found in residential design.
6. Draw a simple landscape plan.
7. Select plants to use in the simple plan.

MOTIVATION:

What is landscape design?

Show the benefits of investing time and effort into landscaping.

REFERENCES:

Landscaping Your Home, Agricultural Education Service, Ohio State University

Landscaping Your Home, University of Illinois

Identifying Horticultural Crops Manual, Purdue University, HO-55

Handout: "Landscaping at Home", Purdue University, HO-111, 112, 113

Landscape Architecture, McGraw-Hill Book Co., Inc.

OUTLINE:

A. Landscape Design:

The art of arranging and fitting together of land, plants, and buildings for human use and enjoyment.

B. Motive for Landscaping:

1. Beautification of the home.
2. Increased value of the property (approximately 10% to 15% of the house value).
3. Provide privacy for family activities.
4. Provide protection from unfavorable weather conditions.
5. Make the space around the home more usable.

C. Basic Design Principles:

1. Simplicity. The elimination of any detail which does not significantly add to the total design.
2. Variety. The difference in form, texture, or color within a restricted number of differing design elements used in a composition to prevent boredom.
3. Balance. A visually harmonious placement of elements within a composition. Can be achieved either through exact symmetry or by asymmetrical counterbalance.
4. Emphasis. Either an individual item or a single group of items used as a focal point (area of visual dominance within a design.)
5. Gradation. A gradual change in form, color, texture and size of plant materials. (A slow transition from tree canopy to shrubs to ground layer.)

D. Basic Functional Considerations:

1. Circulation patterns; people, vehicles.
2. Specific use areas; shade, wind breaks, erosion control.
3. Family activities; garden, patio, play area, pool, orchard.

E. Three Main Landscape Areas:

1. Public area. The space in front of the house. Front yard, driveway, walks, entrance... Suggestions for landscaping front area:

   a) House should be focus of the design
   b) Locate trees to frame the house
   c) Locate walk along the most logical course from house entrance to parking area and/or street
   d) Keep plant material in scale with the house and lot size
   e) Avoid the use of large plants near the house entrance which could eventually obstruct it

f) Reserve specimen plants and objects for use in the private area

2. Private area Also called the living area, this incorporates the space at the rear and/or along the sides of the house. Suggestions for landscaping the private area:

   a) Keep family needs and recreational interests in mind
   b) Locate area so it can be conveniently seen and used from the house
   c) Use trees to serve as backdrop for the house as seen from front
   d) Plan for plenty of lawn and shade
   e) Locate plantings where they may be seen from inside the house and from other outdoor areas on the property
   f) Arrange plantings to frame good "off-property" views and screen undesirable ones.
   g) Screen for privacy

3. Service area. Typically occurs either behind or along the sides of the house; this area is used for storage of tools, machines, trash cans... Suggestions for landscaping service area:

   a) Locate convenient to kitchen, garage and drive
   b) Limit size to space needed to meet minimal space requirements
   c) Screen from other outdoor areas

F. The Design Process:

1. Program list. Compose a list of property owner's needs. This should include specific items like patio, deck and guest parking space in addition to particular activities which are of interest such as bird watching, tending flowers, etc. Specific structures and approximate dimensions of spaces should be defined.

2. Site analysis. Draw a plan view of existing conditions on graph paper to scale (best to use paper with 10 squares to the inch,) refer to HO-111.

3. Draw a plan to achieve maximum organization of design elements; this space provides a realistic, functional framework for the total design thus avoiding an eccentric approach to design.

TEACHING LEARNING ACTIVITIES:

1. Discuss some basic definitions, etc. before getting into basic design (using outline information).

2. Invite local landscape people to class to discuss the landscape business with students.

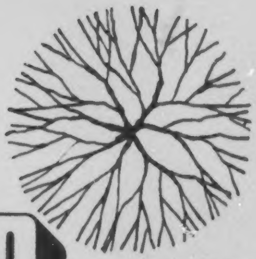
3. Conduct field trip to outstanding local landscaped sites.
4. Show and discuss landscape plans with the class.
5. Have students draw a simple plan.
6. Prepare a handout for commonly used landscape plants for your area.
7. Use the horticultural crop manual to identify landscape plants.

SUGGESTED EVALUATION:

1. Construct a matching exercise using plants, pictures, slides, or other visual aids and have students match the plants with the names commonly used in the area.
2. Evaluate students' landscape plans.
3. Give written test to evaluate students' knowledge of the basic design principles in landscaping.

HO-111

Landscaping at Home



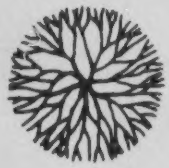
HORTICULTURE DEPARTMENT
COOPERATIVE EXTENSION SERVICE
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

Your home is probably the major investment of your life. It deserves the most attractive setting you can give it. Merely planting trees and shrubs around your home is not landscaping. Designing a proper landscape setting for your home is an art. It requires careful consideration to create and preserve beauty and make the surroundings useful at the same time. Some may ask, why landscape at all? There are many reasons...

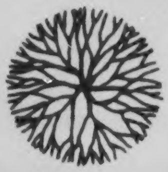
- Landscaping can help you get maximum use from your residential property.
- It will improve the day-to-day living environment and the environment that others see.
- It will help you receive full value from the investment you have made in your home.
- It will increase your property resale value. A well designed landscape can increase the resale value of your home an average of 15 percent (a $3,000 to $5,000 increase for the average home sold today.)
- Proper landscape design will mean easier maintenance.
- A planned landscape will achieve greater economy and efficiency in construction and planning than a "shot-gun" approach, which places plants and other elements at random without proper consideration for the total effect.

The basic purpose of landscaping is to create a pleasurable, functional, and personal environment. The best landscape for any home reflects the personalities of the homeowners and emphasizes the desirable characteristics of the site.

WHAT IS YOUR MOTIVE FOR LANDSCAPING?



1. Privacy?
2. Easy maintenance?
3. To preserve a view?
4. Beauty?
5. Protection from weather?
6. Other?



Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

Try to determine just what has motivated you to start, or want to start your landscaping. The checklist below may help you to pin-point your landscape needs, wants and desires. In general, they will fit your family activities, and the characteristics of your home site.

HUSBAND: Age______ Occupation ____________________

Hobbies:____________________

____

Yard work is:______Torture, ______Just another job, ______Fun. Hours per week you like to spend in the yard,______

WIFE: Age______ Occupation: ____________________

Hobbies:____________________

____

Yard work is ______Torture, ______Just another job, ______Fun. Hours per week you like to spend in the yard,______

CHILDREN: BOYS-______ Ages: ____________

GIRLS______ Ages: ____________

What are their special hobbies, sports preferences, or entertainment needs that require use of the yard.

____

____

Check-List of Desired Family Activities:

A PATIO yes:______, no:______

If yes, for: barbecuing______, relaxing______, entertaining______, how many?______, other______

DESIRED SPORTS AREAS yes:______, no:______

If yes, for: shuffleboard______, croquet______, badminton______, horseshoes______, other______,

Specify other sport. ____________________

PLAY EQUIPMENT DESIRED yes:______, no:______

If yes, for: swings______, sand box______, jungle gym______, slide______, play house______, other:______ specify ____________.

A GARDEN yes:______ no:______

If yes, for: flowers______, vegetables______, fruits______, salad garden______ other______

Size of garden: large______, medium______, small______

Other Development Considerations:

We will need parking for ______ cars.

Guest parking? yes: ______ no: ______ How many ______

A dog pen or run? yes: ______ no: ______ Size ______

Garden tool and equipment storage? yes ______ no ______

Clothes drying area: yes ______ no ______

Trash burning or collection area: yes ______ no ______

Fireplace wood storage: yes ______ no ______

Other storage: boat, etc. ______

Entry walk: yes ______ no ______ Service walk: yes ______ no ______

Fenced yard: yes ______ no ______ See through: yes ______ no ______

Site-Dictated Development Considerations:

Are the trees and shrubs already on the site in good condition? yes ______ no ______

Do some of the trees and shrubs need to be removed? yes ______ no ______

Does topsoil need to be added? yes ______ no ______

Is the drainage on and off the site adequate? yes ______ no ______

Is there drainage from a neighbor's property? yes ______ no ______

Is there drainage on to a neighbor's property? yes ______ no ______

Are there bodies of water or rock outcroppings on your land that you may want to feature? yes ______ no ______

Do you have any step slopes that will require retaining walls or special plantings to stabilize? yes ______ no ______

Are there eroded areas that will require immediate attention? yes ______ no ______

Does your neighbor's ground elevation effect your landscaping plans? yes ______ no ______

Do you want more privacy and protection in your living area? yes ______ no ______

Do you want to change your neighbor's view of your property? yes ______ no ______

Do you need to enframe a good view or screen out an undesirable one? yes ______ no ______

Are there adjoining pleasant areas such as a golf course, a park, ets. that you can take advantage of in your plan? yes ______ no ______

Do you need protection from the prevailing winds in certain areas? yes ______ no ______

USE THIS SPACE TO LIST OR DESCRIBE OTHER THINGS THAT YOU WANT TO BE SURE TO REMEMBER WHEN DESIGNING YOUR LANDSCAPE PLAN...

Most of us will agree that a well landscaped yard is better. However, some will say, "why draw a landscape plan?"

- A plan helps you to think of the total landscape instead of just its parts. This just naturally leads to a better overall relationship for the site.
- A plan allows you to try different landscaping ideas — on paper, where mistakes are easily corrected and cost next-to-nothing.
- It is the best way to study and organize outdoor and indoor relationships.
- A plan allows development to occur over a period of time. This has many obvious advantages, the most important being that it is easier on the pocket-book.
- A plan helps to keep tabs on details.

REMEMBER... Trees, shrubs, and outdoor design elements are expensive. A wise homeowner who is considering landscaping can avoid costly mistakes and improve the final results by first making an analysis on paper.

HERE'S A LIST OF EQUIPMENT YOU WILL NEED TO DRAW YOUR PLAN...

- 1 - HB Drawing pencil
- 1 - H Drawing pencil
- 1 - Art gum eraser
- 1 - Circle template
- 1 - Three-ring binder
- 1 - Engineer's scale
- 1 - Pink pearl eraser
- 1 - 30° - 60° triangle or 45° triangle, 8" or larger.
- Several sheets of 18" X 24" tracing paper or vellum

COMPLETE THE FOLLOWING EXERCISE TO GAIN SKILL WITH YOUR NEW EQUIPMENT.

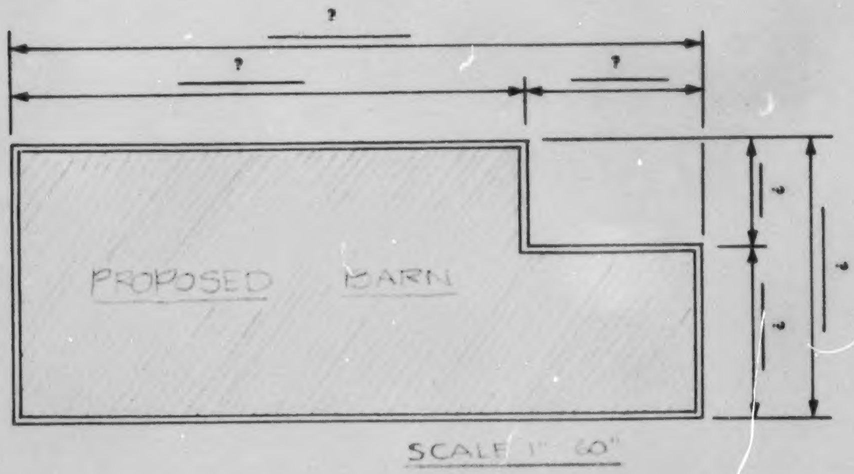
(A)________________________________(B)

1. At the scale: 1"=10'-0" line AB is________________Feet long.
   At the scale: 1"=40'-0" line AB is________________Feet long.

(M)____(N)

2. At the scale: 1"=10'-0" Line MN is________________Feet long.
   At the scale: 1"=20'-0" Line MN is________________Feet long.

3. Below are given the outside dimensions of a building shown in PLAN view. What are its dimensions, in feet & inches?



4. Select and draw the circle from your template which represents each of the following measurements.

(a.) A diameter of 30' at the scale: 1"=30'-0".

(b.) A radius of 40' at the scale: 1"=50'-0".

(c.) A diameter of 5' - 6", at the scale: 1"=5'-0".

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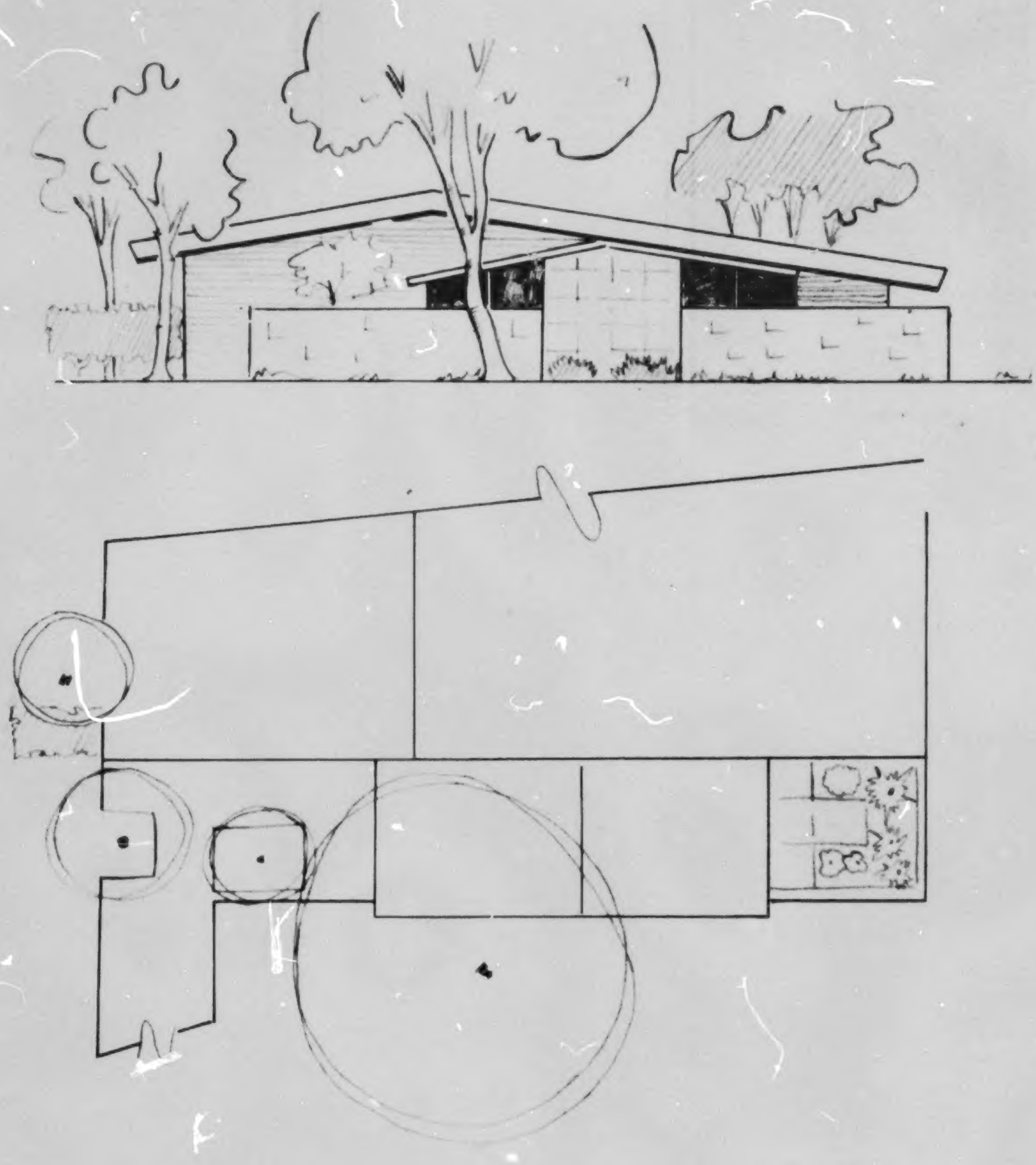
5. A TYPICAL HOUSE PLAN

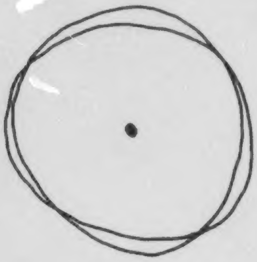
Locate trees, shrubs, and other elements as required on each page. This exercise is designed to help you see the relationship of the **normal view (elevation) and the plan view.**



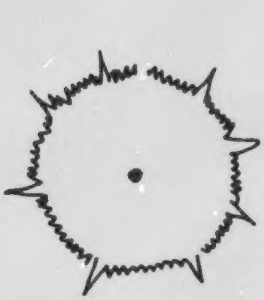
These are an **ELEVATION** of a house and the **PLAN VIEW** of the front yard. Do you see the relationship? **The elevation is looking** straight at the house and plan view sees it from above.

Here are several landscape planning symbols that you will need when you draw your plan. Practice drawing each symbol to the right of the one given.

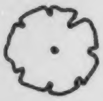
1. **Deciduous tree** (size of the circle equals the diameter of the full grown tree.)



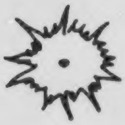
2. **Evergreen tree** (size of the circle equals the diameter of the full grown tree.)



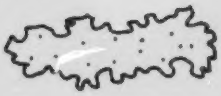
3. **Deciduous shrub**



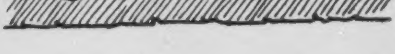
4. **Evergreen shrub**



5. **Ground cover plants**

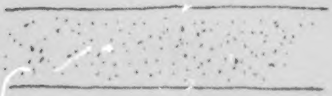


6. **Sheared hedge**

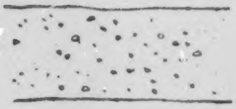


More symbols that may be needed for your plan.

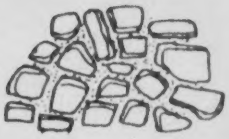
7. **Gravel surface**



8. **Concrete surface**



9. **Flagstone or Cut-stone surface**



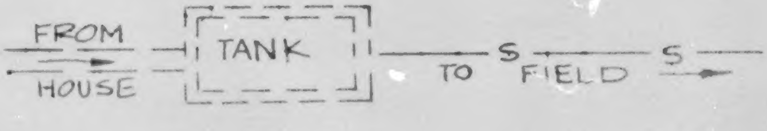
10. **Electric line** ——— E ——— E ———

11. **Gas line** ——— G ——— G ———

12. **Sewer line** – – – – S – – – – – S – – –

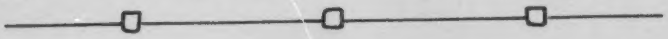
13. **Telephone line** ——— T ——— T ———

14. **Septic tank system**

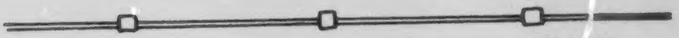

FROM
HOUSE
TANK
TO
S
FIELD
S

Still more symbols. In general, any symbol represented here or any additional symbol that you may need should be drawn as it would appear from a view directly above the object.

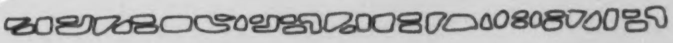
15. Open or wire fence



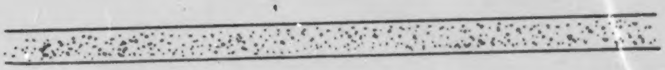
16. Screened or solid fence



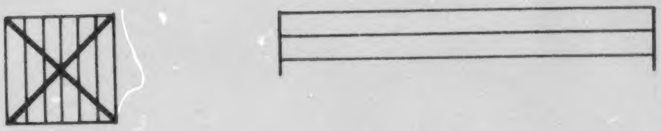
17. Rock retaining wall



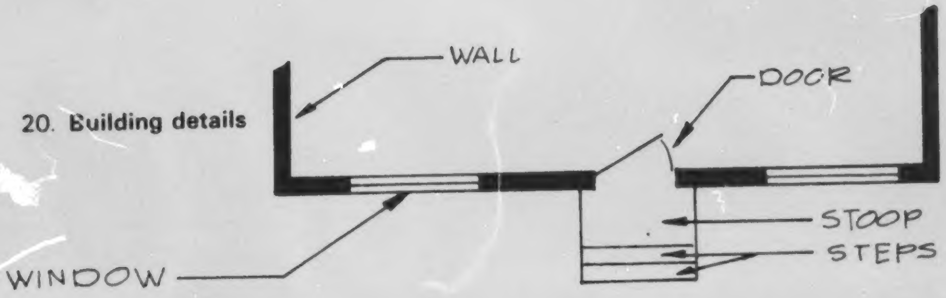
18. Concrete retaining wall



19. Clothes lines

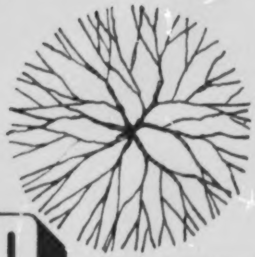


20. Building details

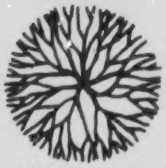


HO-112

Landscaping at Home



HORTICULTURE DEPARTMENT
COOPERATIVE EXTENSION SERVICE
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907



Your home has its own character that determines the basic landscape site design. Consider the ground forms on your property—the slopes, hills, or the valleys. They are a part of the existing similar land formations in your area. One of the first requirements in any type of development is to preserve enough of the present elevations and land formations so the overall design for your site stays in harmony with its surroundings.

Think of your land as a single unit of an entire area, not as an "island" unrelated to the adjoining land areas.

Keeping that in mind, in this lesson you will analyze your home site, outline the various use areas you want for your plan, and make some basic decisions about constructed features (patios, fences, benches, etc) for your home.

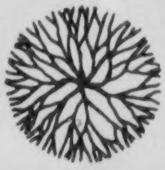
Before you begin the development of your yard, be sure that you know the exact boundaries of your property. The boundary corners are often marked with long iron pins. The pins may be two or three feet long and nearly ½" in diameter. They are usually driven into the ground with only an inch or so showing.

You will have the responsibility for maintenance up to the curb of the street, however; your front property line will normally be 10 or 15 feet back from the curb. Often, in the city, the inside-edge of the front sidewalk is the front property line of your lot.

Most properties or building lots have an easement at the back of the property. Normally, this easement is 10 to 15 feet wide. Half of the easement will fall on your property and the other half on the property behind you. This easement has been set aside for utilities needed to service your house. You own the easement, but the city and the utility companies have the right of access to the easement if needed to service their equipment. It is best, and often mandatory, not to install anything permanent, such as fences, sheds, or plant materials in the easement.

All incorporated cities have ordinances that restrict how close to your property line you may build. Sometimes these ordinances also have clauses that restrict how close you may plant. To be sure that you are legal, check with your city engineer or other appropriate agencies to obtain information for your site. In most cases you can be safe if you stay back 25′ from your front property line, 10′ from your side property lines, and 25′ from the back line.

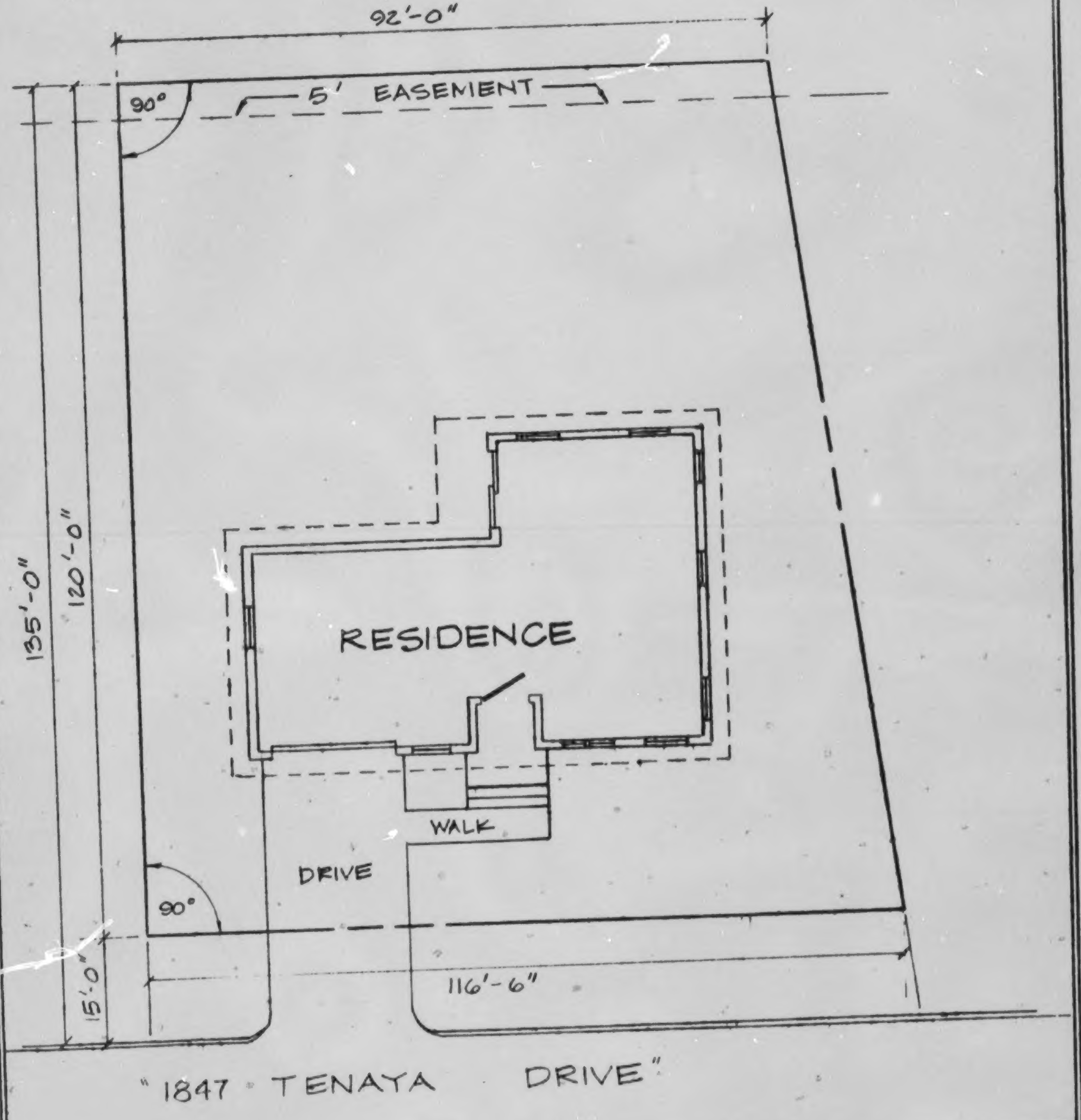
On the following pages, draw your home site as accurately as possible. Indicate which direction is north, and locate your house within it. If you have questions on how to do this, look at the example.



by Lawrence B. Zuercher, Landscape Architect 683

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

"SITE LAYOUT EXAMPLE"


92'-0"
5' EASEMENT
90°
135'-0"
120'-0"
RESIDENCE
WALK
DRIVE
90°
15'-0"
116'-6"
"1847 TENAYA DRIVE"

HOME LANDSCAPE WORKSHOP
DESIGN FOR.:
MR. & MRS. J. Q. HOMEOWNER

SITE LAYOUT PLAN
BY: MRS. J. Q. H.
DATE: 4/12/81
SCALE: 1"=20'-0"
N

HOME LANDSCAPE WORKSHOP
DESIGN FOR:

SITE LAYOUT PLAN

BY:

DATE:

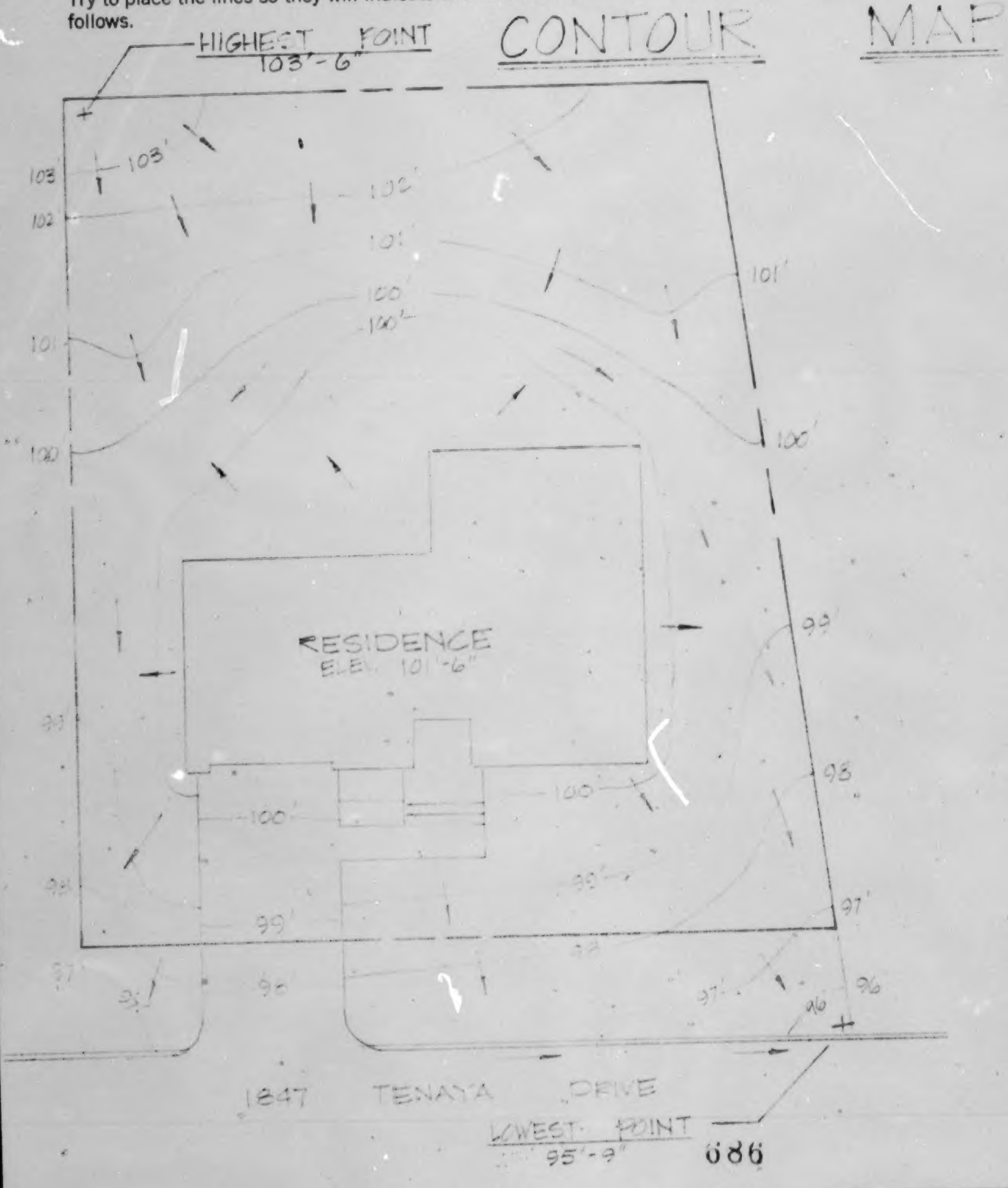
SCALE:

Adding site details

Now that you have the basic site information for your home recorded on your plan view, it is time to add some details useful in analyzing the site.

One of the most important aspects of any analysis is to determine the "lay of the land." If you have a contour map of your home site you're one step ahead. However; a rough contour map can be constructed from some basic information which you probably already know.

Place a single sheet of tracing paper or vellum over the basic layout map you have just constructed. Secure it in place. Indicate on the tracing paper or vellum the location of the highest point and the lowest point on your site. Draw lines on your map that follow the contours found on your site. Try to place the lines so they will indicate one foot interval changes in elevation. See the example which follows.



CONTOUR MAP
HIGHEST POINT 103'-6"
103
103'
102
102'
101'
101'
100'
100'
101
100
100'
RESIDENCE
ELEV. 101'-6"
99'
98
100'
100'
99'
99'
97'
97'
96
97'
96
96
1847 TENAYA DRIVE
LOWEST POINT 95'-9"

After you have drawn contour lines on your plan, place small **arrows** (referred to as flow indicators) to show the direction of water flow on your site.

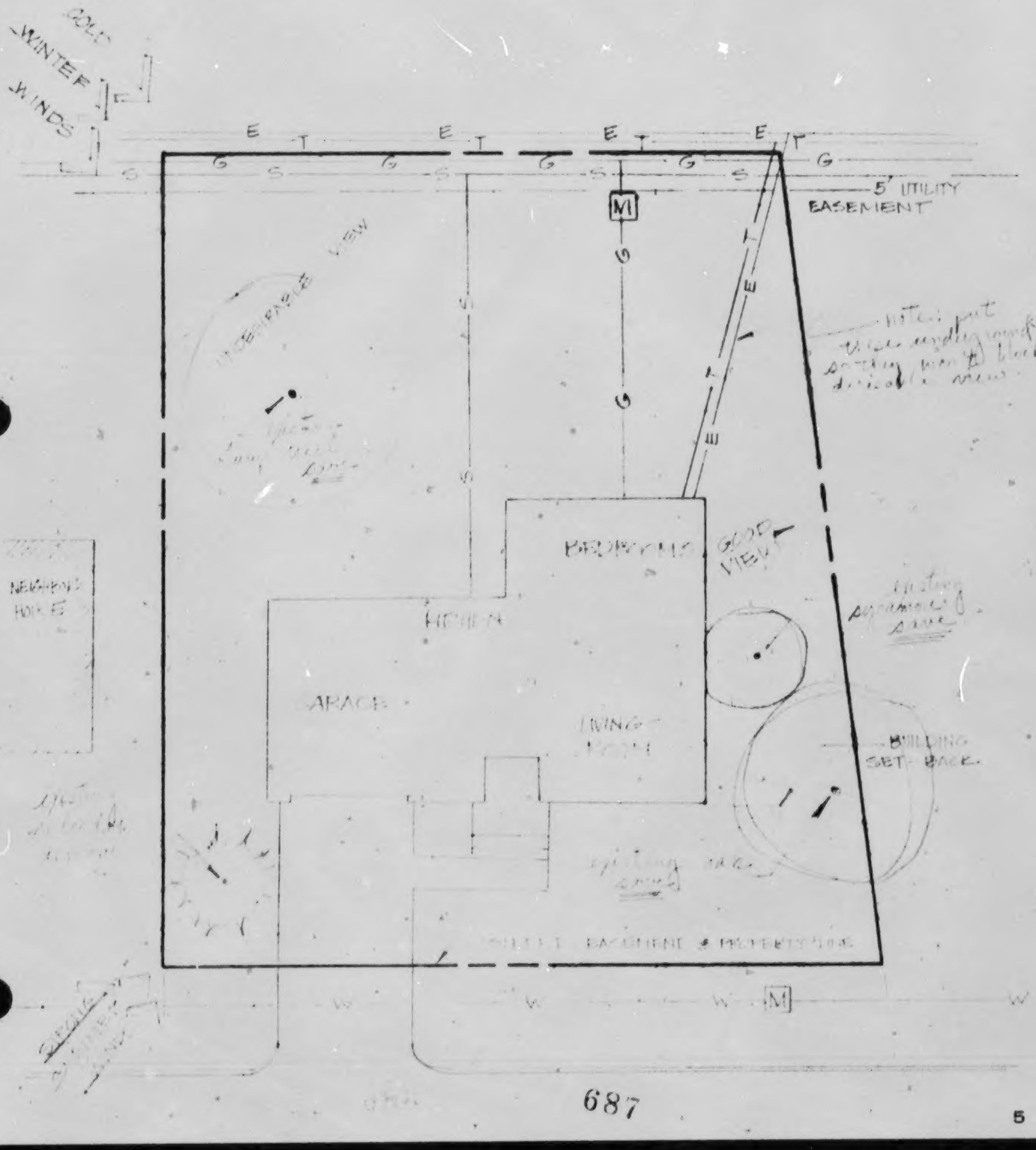
Now, place a different sheet of tracing paper or vellum over the basic layout plan and indicate as many of the following factors that apply to your home site. Use the symbols given in the first lesson.

Underground and above ground utilities

gas line
sewer line
water line
TV cable
electric line

Good views
Undesirable views
Neighbor's houses
Interesting site features
Gas meter

Water meter
Manholes
Building setback line
Direction of winds in summer and winter.
Existing trees and shrubs and their approximate sizes.


COLD
WINTER
WINDS
E
T
G
S
M
5' UTILITY EASEMENT
UNDESIRABLE VIEW
note: put [illegible] to block [illegible] views
BEDROOMS
GOOD VIEW
KITCHEN
GARAGE
LIVING ROOM
existing sycamore save
BUILDING SET-BACK
NEIGHBOR'S HOUSE
existing oak save
STREET EASEMENT & PROPERTY LINE
W
SPRING SUMMER WINDS

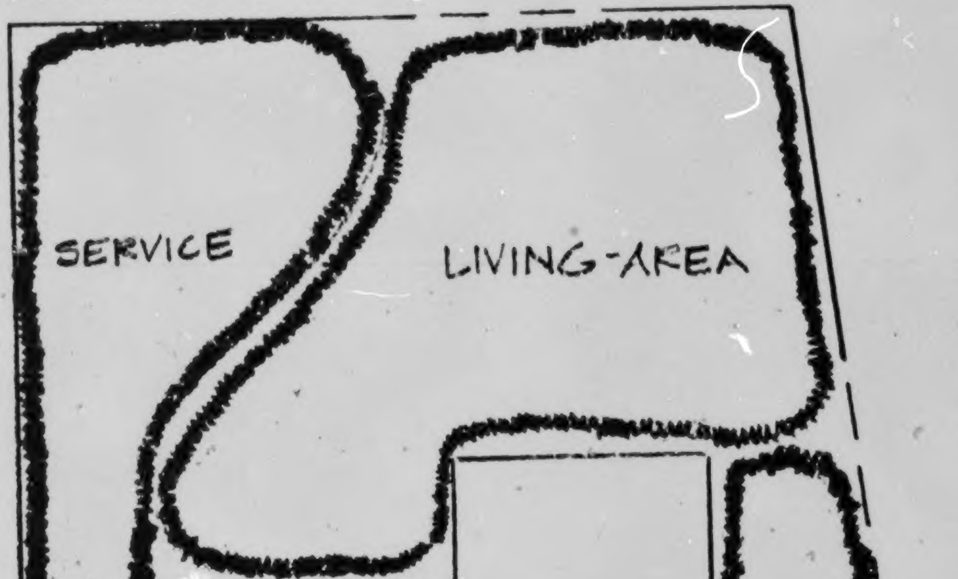
Planning major areas

Nearly all families need three major landscape areas in their yards — **the living area, the public area, and the service area.**

The living area may be looked at as a true extension of your indoor living space. It is a place where patios are built, lawn games are played, maybe a swimming pool is placed there, swings and slides and possibly even a playhouse belong here.

The public area is that portion of your property which the public sees as the setting for your home. It is true that the front yards of most houses help to provide the community with a pleasant appearance and benefit the dwellers little. The public area should invite guests to your front door, and may possibly provide additional parking for visitors.

The service area, sometimes called the work area, is too often overlooked in residential design. When it is, the result is obvious. In the service area, undesirable objects are placed so they may be screened from view. Things such as trash containers, clotheslines, compost piles, loose trash storage area, and maybe even a storage unit for garden tools. These items are not attractive in the landscape but they are essential to the running of the household. This area is best located adjacent to the service side of the house, such as the utility room door. Generally, an area ¼ to ⅓ of the total backyard is needed for the service area.



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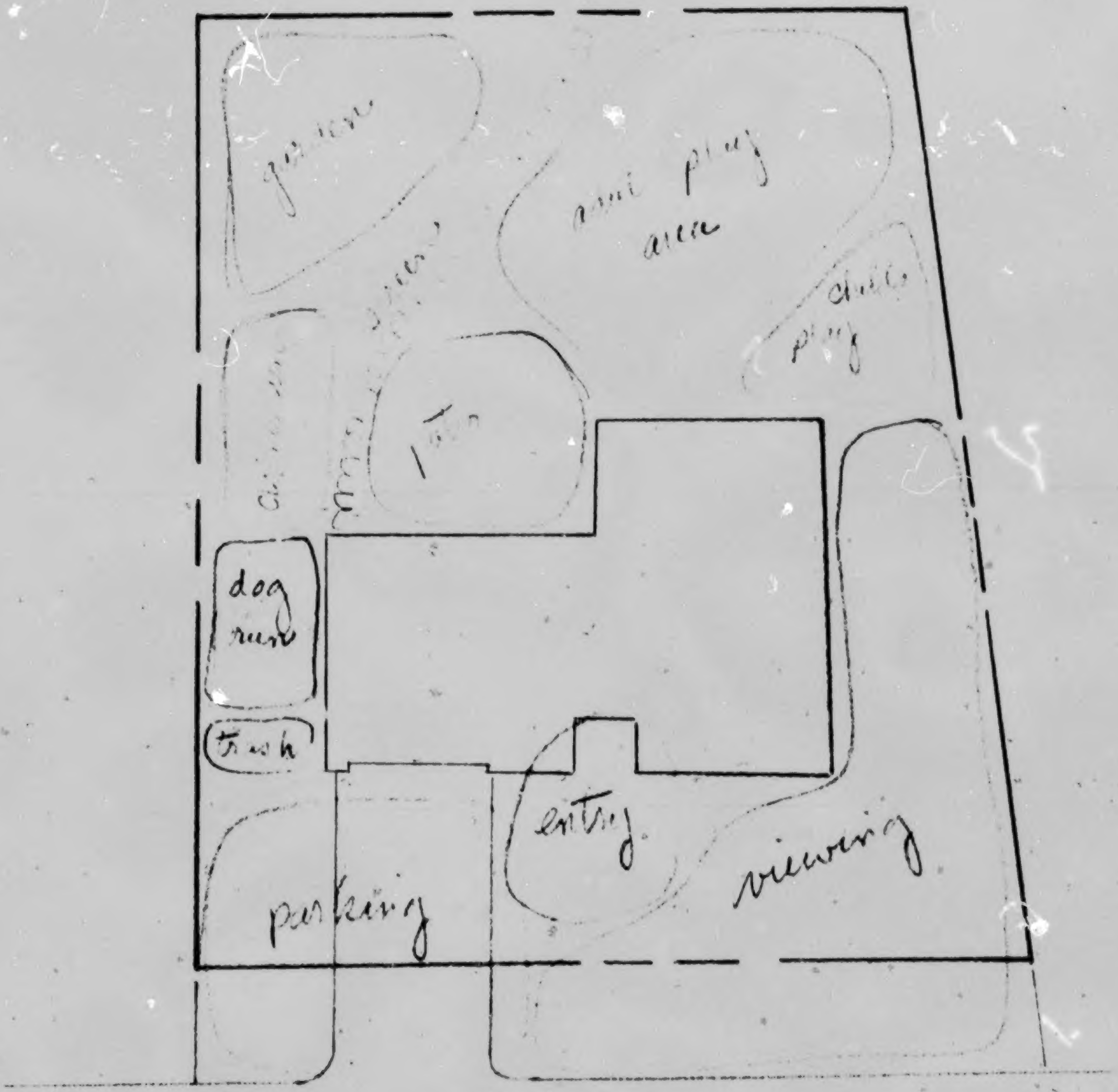
Your next step in planning your landscape development is to divide your home site into the three major areas. (See the examples.) These three major areas should then be further divided to show locations of specific uses. For example, the living area might be divided into smaller specific areas for adult play, child's play, and a patio. The service area may include smaller areas, such as space for a garden, clothes line area, a dog run, and trash container area. Now is the time for you to refer back to the "check-list" you completed in lesson one to be sure you include all of your wants, needs, and desires.

Place a piece of tracing paper or vellum paper over your basic layout plan and begin.

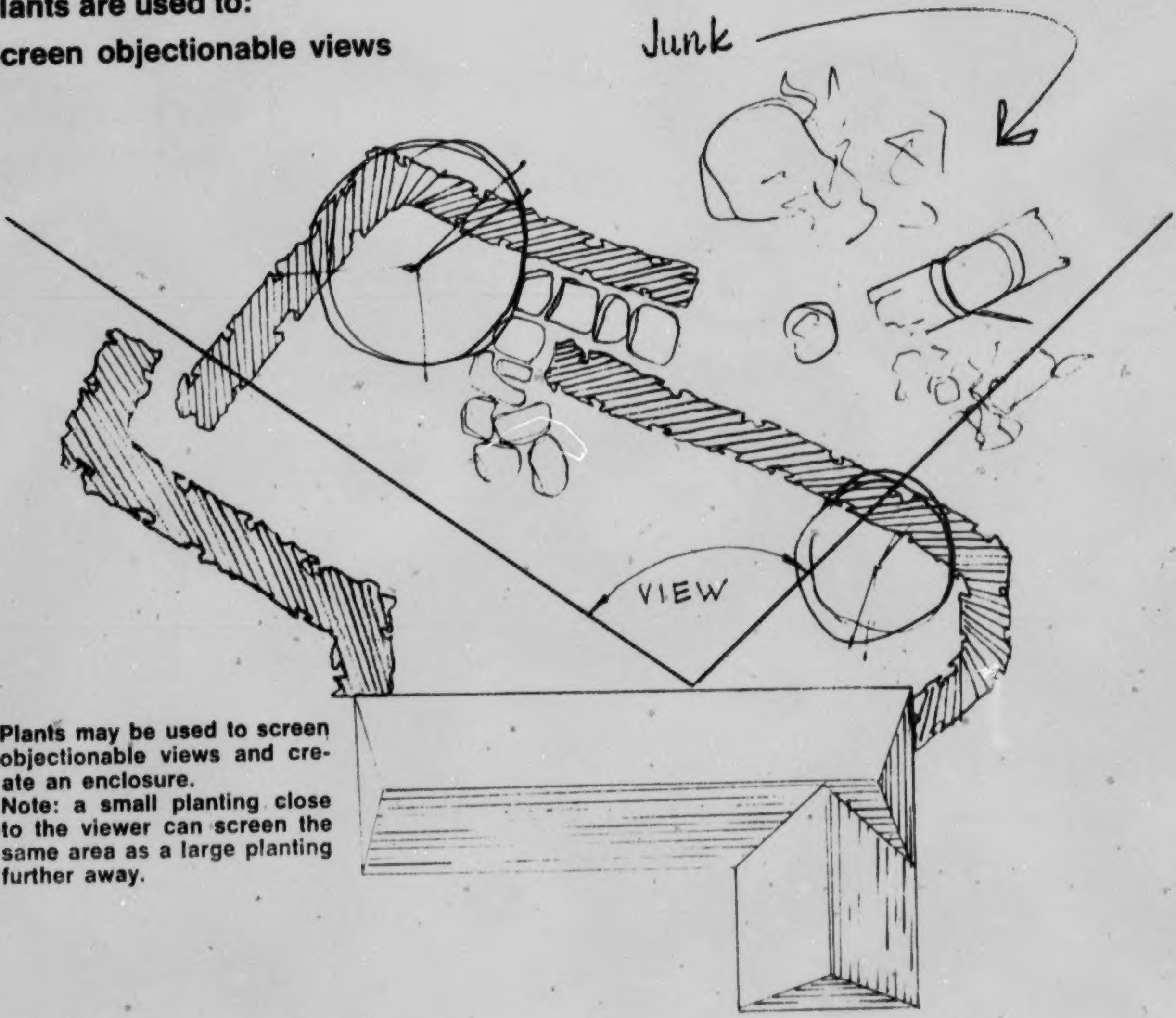


Now that you have completed a major portion of the analysis of your home site it is time to consider the following information before making any additional decisions. The information presented on the following pages is not complete. However, it will give you some examples and insight on how to use plants in your plan and it will show you some alternative choices for construction of fences, patios, etc.

How plantings can be used

Let's begin . . .

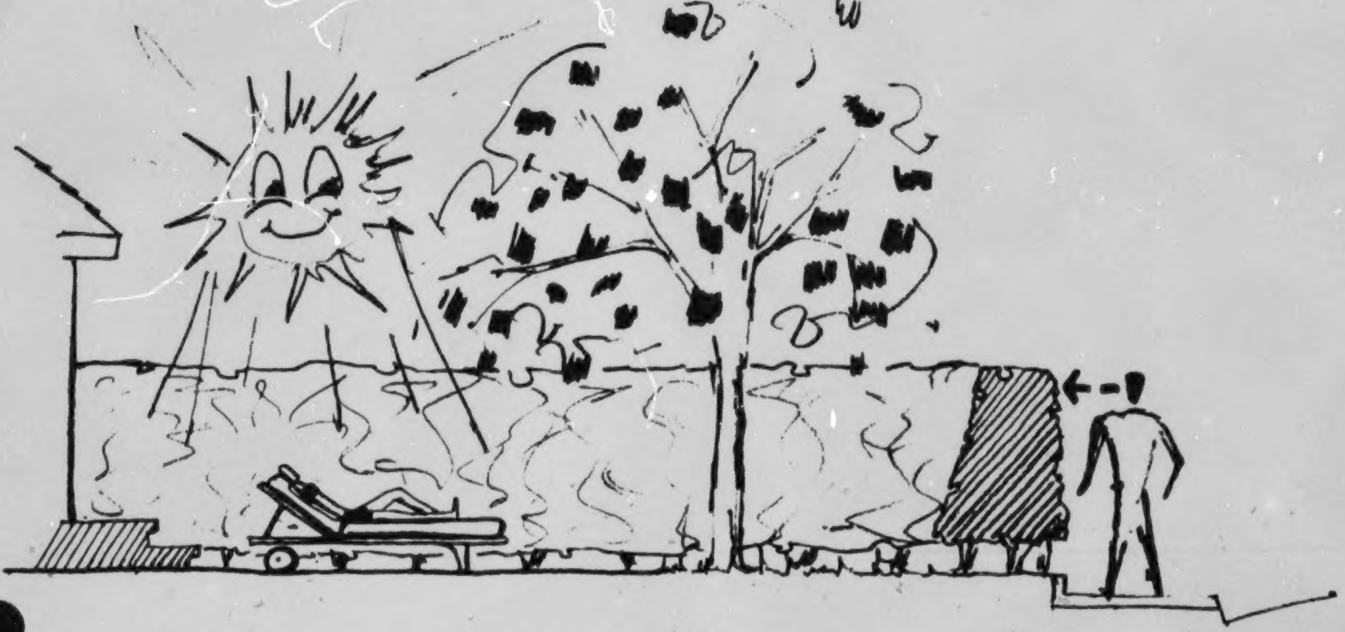
Plants are used to:
Screen objectionable views



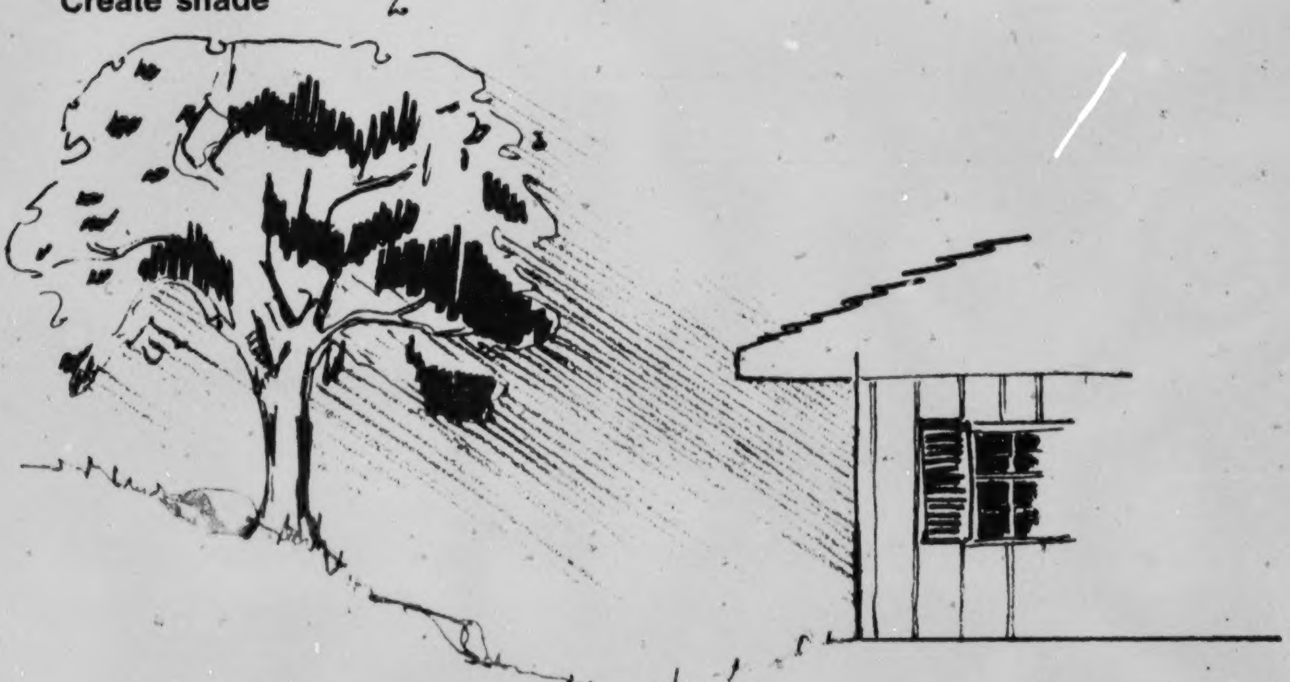
Plants may be used to screen objectionable views and create an enclosure.
Note: a small planting close to the viewer can screen the same area as a large planting further away.

PLAN VIEW

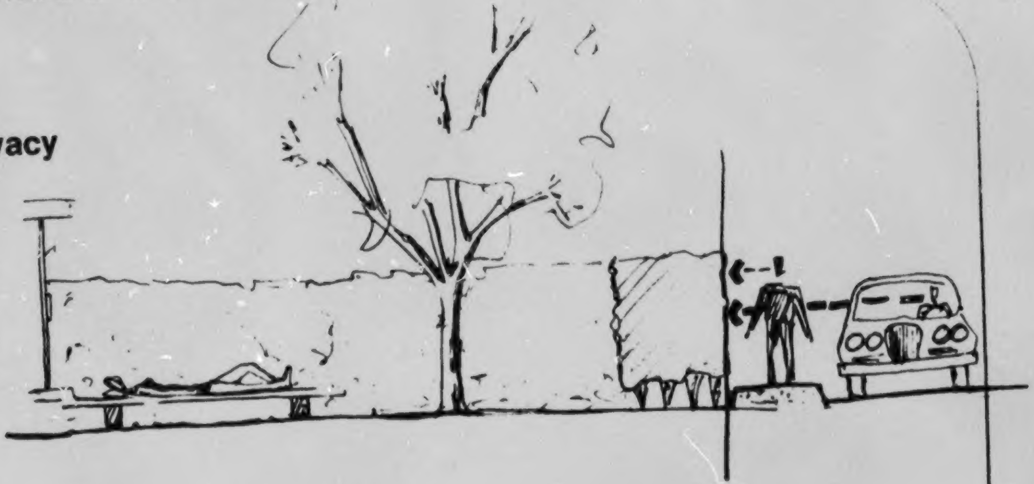
Create privacy



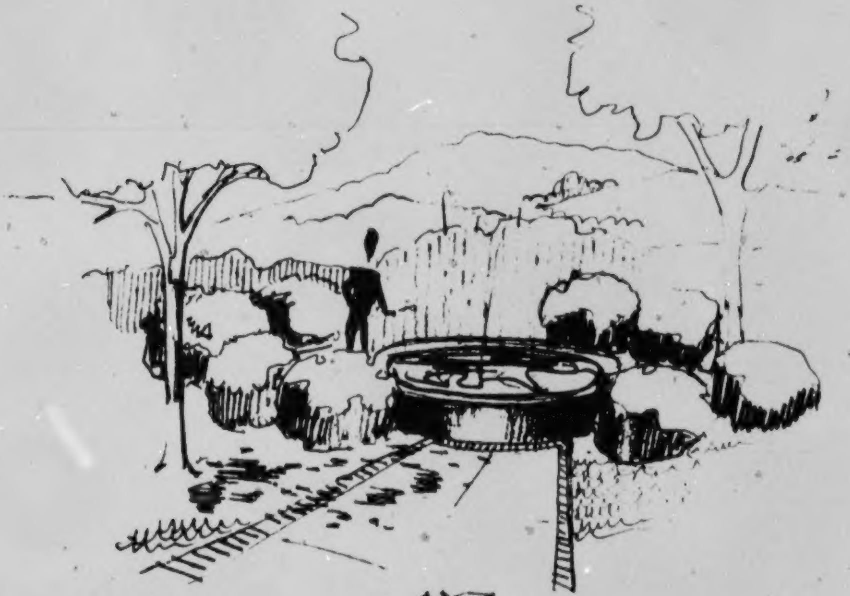
Create shade



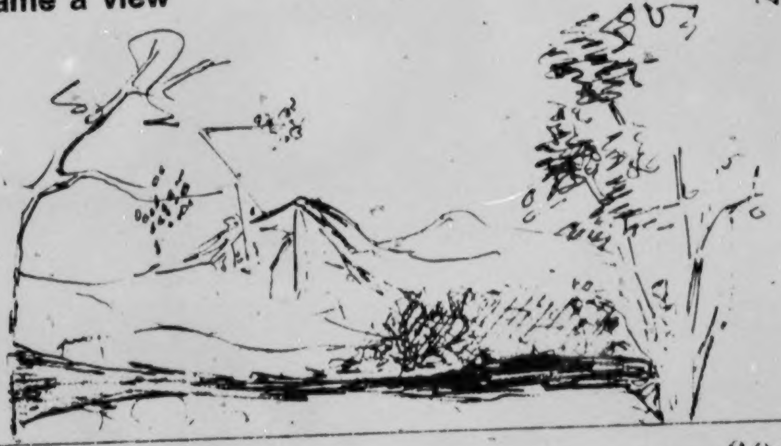
Create privacy



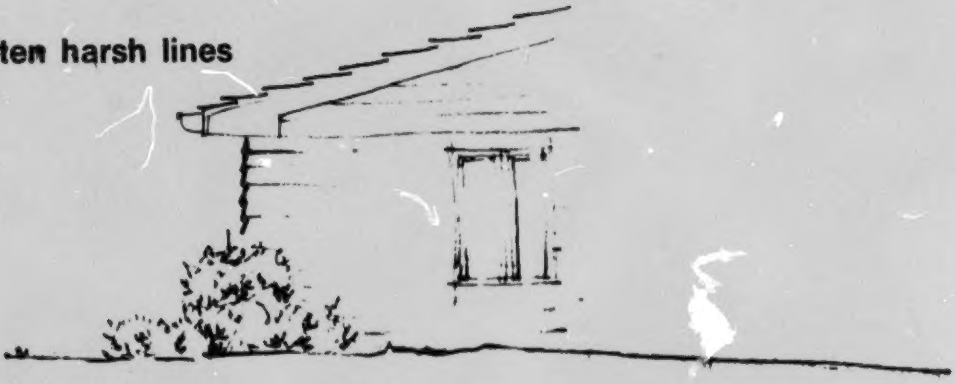
Define a space



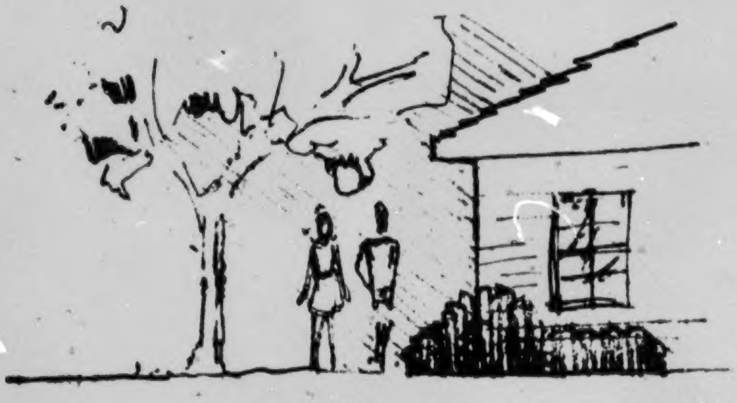
Frame a view



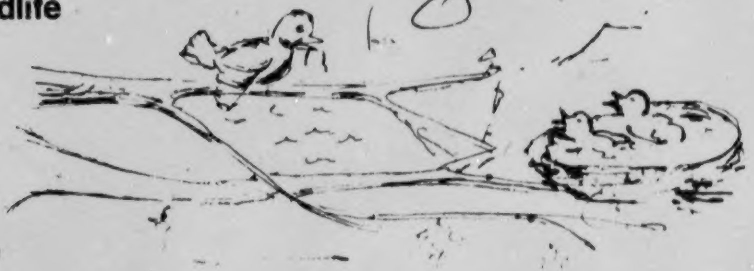
Soften harsh lines



Create shade



Attract wildlife



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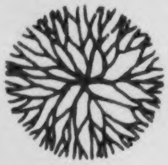
Making choices

As we have seen, any plant should be used only with a sound planting purpose in mind. When they are used in that way they will serve both a design purpose and solve site development problems. Following is a comprehensive listing of uses for plant materials. They are fundamental to any good landscape planting plan.



Use of plant materials

Shade

A. Purpose

- for structure (s)
- for a patio, terrace or deck.
- for lawns, gardens, or specific plants that require shade such as ivy or vinca.
- for animals — pets (such as a dog run.)
- for street trees — large trees 50-60 feet spacing — small trees 40-45 feet. DO NOT use low branched types, such as Pin Oak, here.

B. Time

1. When the area will be used — time of day.
   - Morning — little needed — open tree
   - Noon — medium to large trees or trellis overhead.
   - Afternoon—small trees or vertical trellis. Sun goes under large trees so they must be placed a considerable distance from the area to be effective.
2. Season — the sun is lower in the southern sky in winter and the sun's rays are usually welcome — use deciduous plants for summer shade and winter sun.

C. Space Available

1. Large trees — do not plant closer than 25 feet from structure, and they can be spaced about 30 feet apart if grouping.
2. Small trees — 15 feet from structure, can group these trees for naturalistic effect.

Framing

A. Provide an attractive frame for structures, an entrance or a specific architectural detail. Usually this enframement is viewed from approaches to the object such as from the street, a drive or a walk.

B. Views from a patio, a picture window, or certain other areas of the grounds.

Background

A. For structures — keep the tree in scale with the structure. Larger trees should be kept toward the rear of the property and smaller ones nearer the front.

B. For garden plantings. A hedge of privet, boxwood, or euonymus is very effective as a background for annuals and perennials.

C. For plant specimen. A light trunk such as the birch is effective against a green background.

Boundary

A. Plants are used to denote different use areas such as a patio and lawn, or lawn and garden.

B. They are used to mark the edge of property.

C. The size of a plant can be a physical barrier to access and a lower plant can provide a visual boundary or barrier.

Screen

A. Purposes
  - to provide privacy
  - to provide areas of different use
  - to block undesirable views
  - to partially screen pleasant views, thus inducing the desire to explore.

B. Location
  - directly on the object — vines
  - immediately in front of the object — shrubs, trees or a fence.
  - immediately in front of the viewer — shrubs, trees, or a fence.

Accent

A. Purpose — to call attention to a view or object of particular interest.

B. Location — near view, point of viewing or object but not obstructing it. Can use paired plants but the effect is more formal.

C. Type of plant — should stand out or contrast with its surroundings by shape, size, color, or texture.

Changing architectural lines

A. Structure too tall for its width — add large trees to the sides and rear, and use larger rounded or horizontal (spreading) type plant forms in front.

B. Structure too wide and low — use small trees and block portions of the front to break up width. Do not extend plantings far beyond the sides. Carefully chosen vertical or ascending plant forms help if properly placed.

C. Pleasing proportions — this is a compromise of the above.

Softening architectural features

A. Harsh angles—corner plantings can be used to ease the meeting of the structure and the soil.

B. Dominant lines—for example the soil line—Use varying heights to give undulating appearance. However, do not overdo or effect becomes unpleasant.

C. Sloping soil line—Use larger plants at the lower side to help raise it visually.

D. Dominant sections of a structure—Small trees, large shrubs or vines will help to de-emphasize.

E. Monotonous elements such as windows—screen with small trees or large shrubs. Use plants with open foliage.

Emphasizing lines of landscape design

A. Rows of the same plant to strengthen a line
  - Formal—sheared or clipped—usually in geometric forms.
  - Informal—natural shapes of the plant materials or groupings using flowing lines and a free form.

B. Define a space—Use a large mass of the same or similar plant, usually a low-growing type such as a ground cover.

Cover the soil

A. Grass—keep in large, simply shaped panels broken up as little as possible.

B. Ground covers—use in areas where mowing is difficult or where grass will not grow. It can be used under leggy shrubs to reduce weeds, mulch the soil and tie planted areas together.

C. Shrubs—that are full and branched well near the ground.

D. Trees—will not cover the soil alone.

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Seasonal effects

A. Purpose—to add color or interest at certain times of the year by means of flower, fruit, foliage, or bark.

B. Location—unless an accent plant is desired or space is limited, use the same plant or plants at rhythmic intervals.

Shadows

A. Purpose—to give a changeable quality to uniform surfaces such as a lawn, a paving surface or the side of a building.

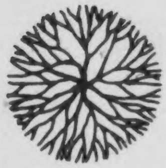
B. Shade or shadow—an open plant or one without leaves casts a shadow pattern. A dense plant gives shade.

C. Location—should place plant in such a location that it will give the desired shade or shadow at a certain time of day.

Specimen plants

A. Purpose—to add character or interest by means of excellence of form, color, texture, or refinement of a single plant. A plant so placed usually serves as a focal point.

B. Location—plant should be placed so it is terminating a view or placed to call attention to a particular area. Do not allow the plant to conflict with other focal points such as building features or flower gardens.



- Plants used because of their flowers, fruit, color of foliage or bark should be placed in front of a dense, contrasting but harmonious color.
- Plants used because of their interesting texture should be backed up with other plant materials or constructed surface with a different texture.
- Trees with an interesting branching habit or foliage outline can be silhouetted against the sky or a large building surface of a contrasting value. That is, light on dark or dark on light.

Ecological relationship

A. Purpose—to give a naturalistic effect by using plants together that would normally be found together in nature because of their common soil, moisture, sun or climatic requirements. This is especially important in park or highway design because it brings down maintenance costs.

Set a mood

A. Picturesque or rugged—mature plants with asymmetrical growth habits and open branching. They should be irregular in shape and show age.

B. Grandeur or dignity—use large or mature plants with a rather symmetrical form such as the spruce.

C. Solemnity or sadness—Use plants with a weeping or drooping branches.

D. Friendliness or cheer—Use medium size trees with graceful branching habits. Plants with leaves that flutter in the breezes or with brightly colored flowers or leaves are fun.

Economic use

A. Fruit and nut trees and shrubs—These plants can be used as integral parts of the landscape if they are planned for initially.

B. Farm woodlot—background for residential setting. It should be viewed across fields or used as a windbreak.

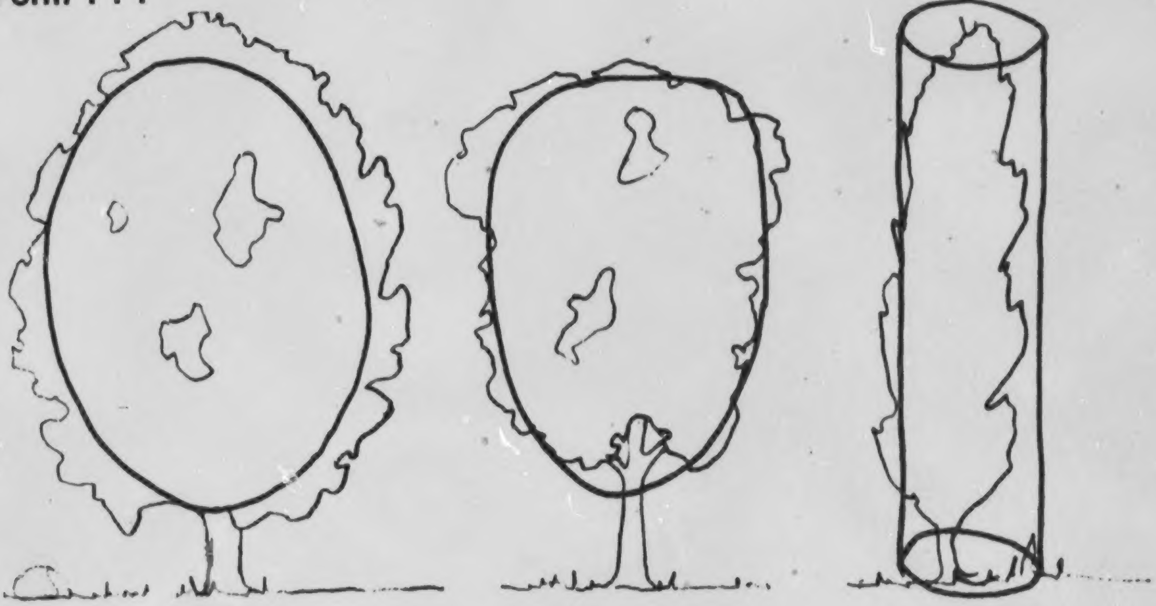
C. Meadows and cultivated fields—Pastures or hay fields can serve as an extension of lawns, and fields add seasonal change to the landscape.

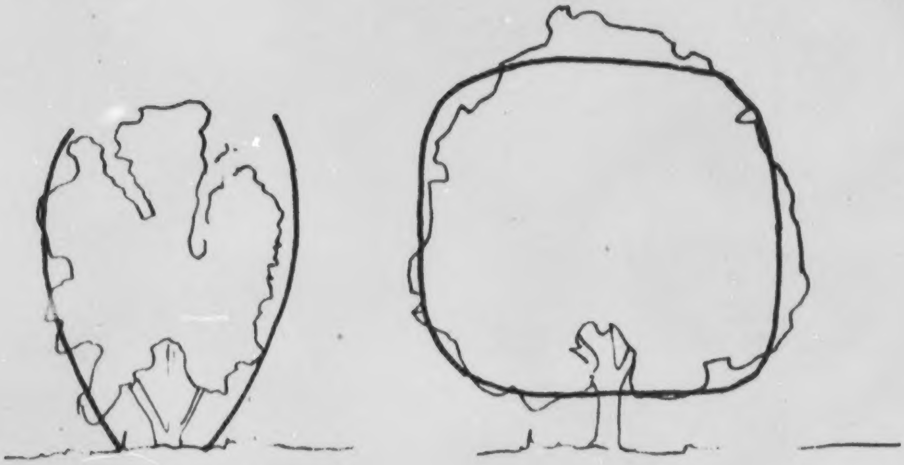
Consider plant characteristics

All trees and shrubs have their own form, color, size, and texture.

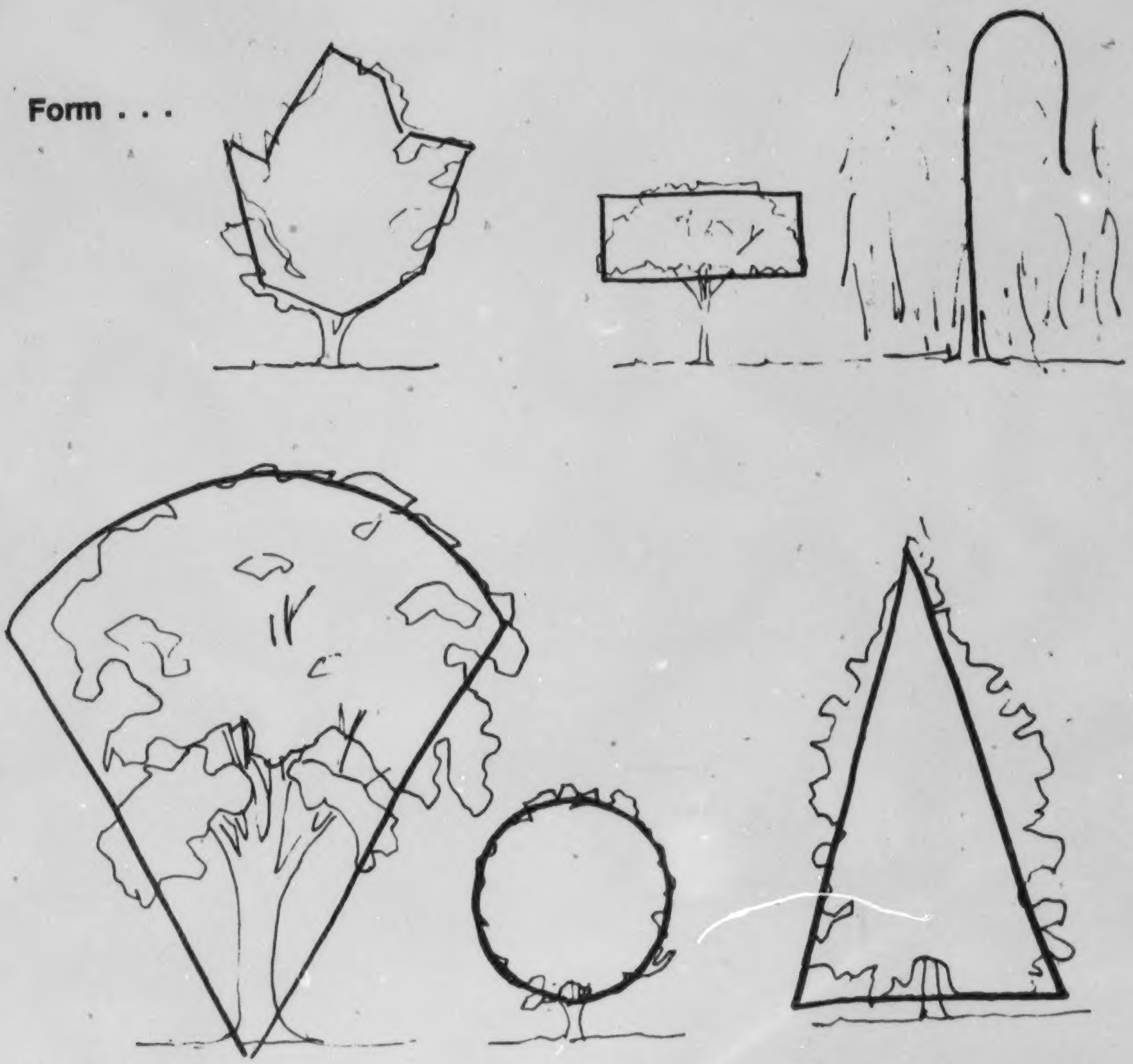
Probably, by casual observation, you have noticed that some trees seem to reach upward and others droop. Some trees have light, yellow-green leaves and others are deep blue-green. I am sure all of us have noticed that some trees get very tall and others remain small. Let's consider these four characteristics, one at a time.

Form . . .





Form . . .



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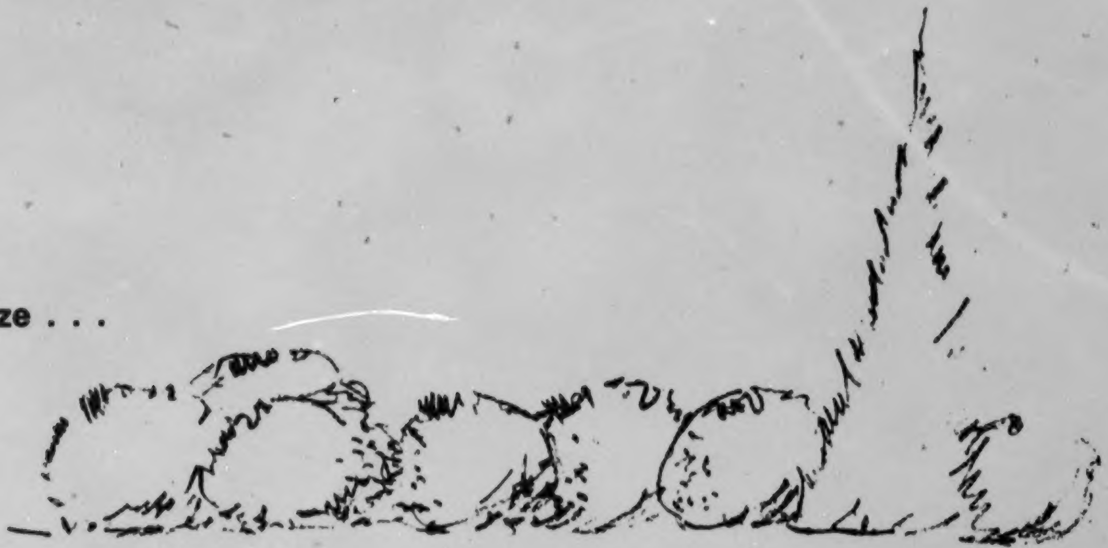
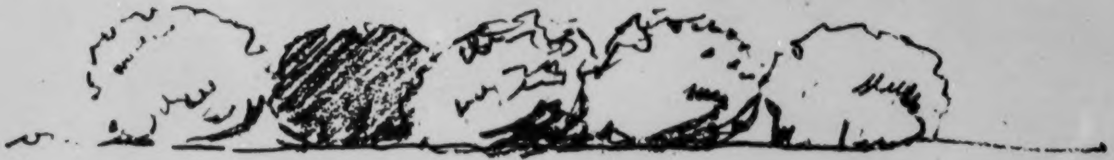
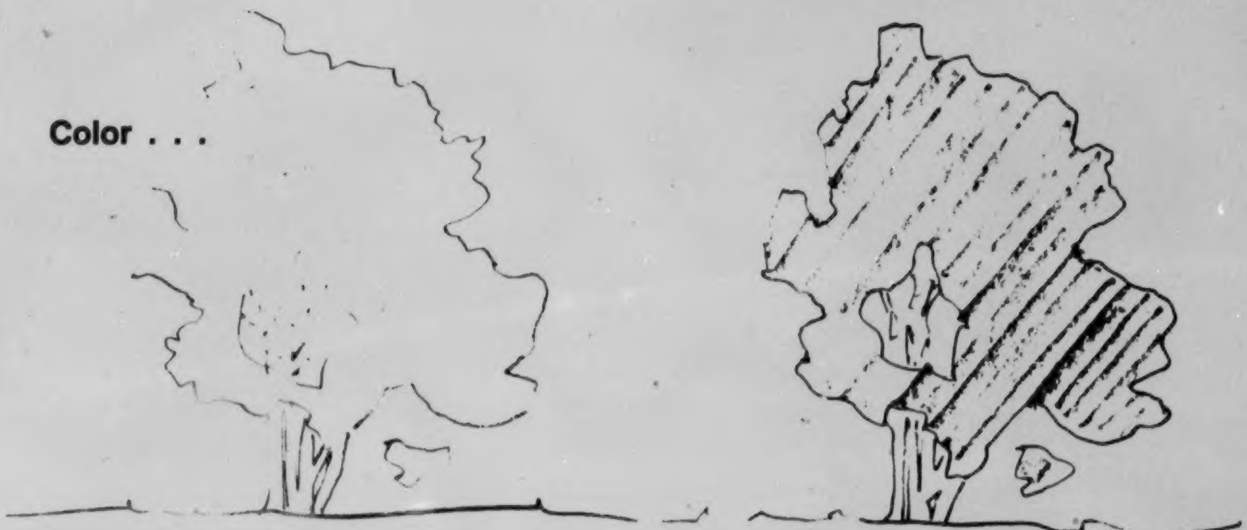
Size . . .

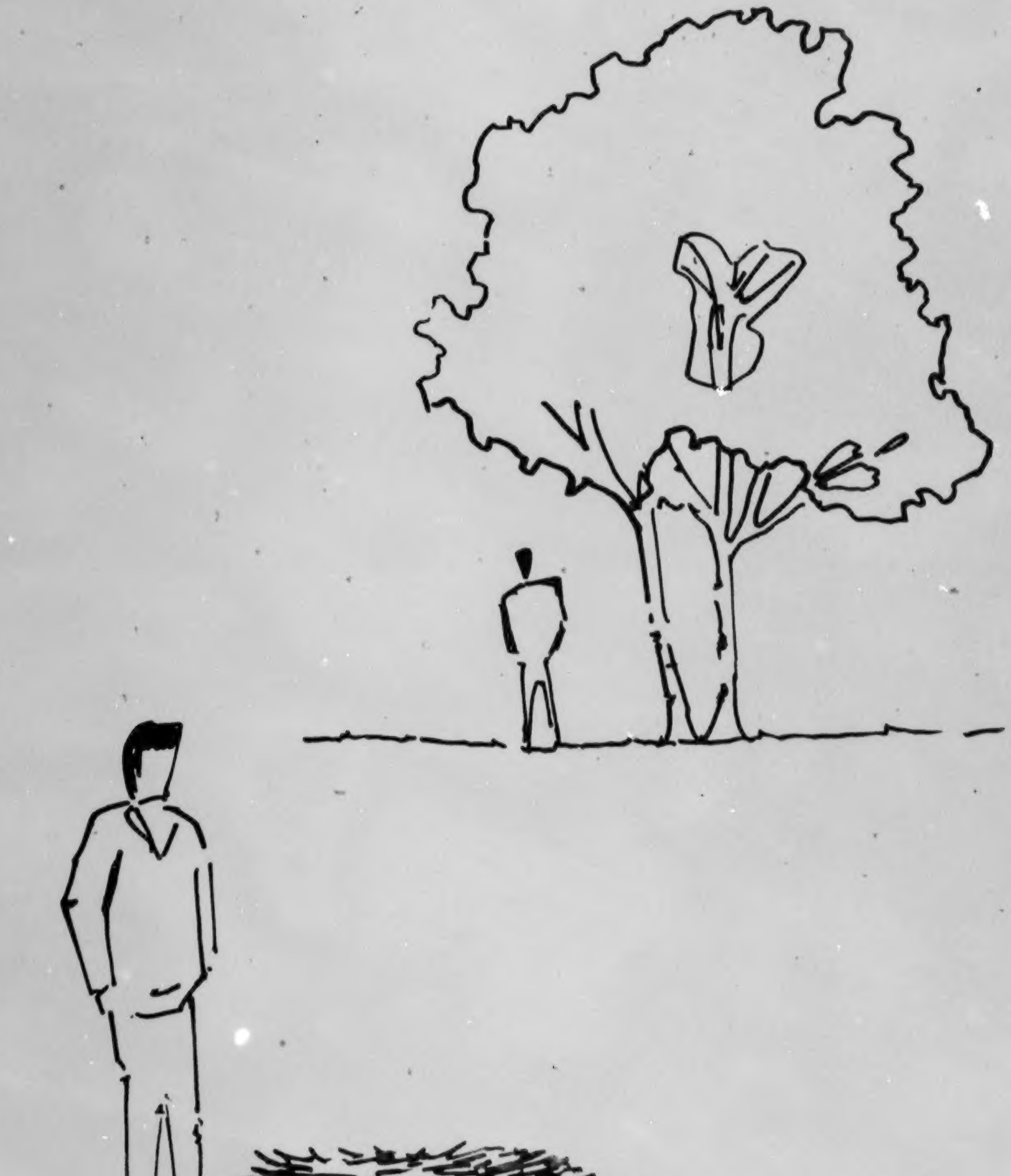


Color . . .



Color . . .





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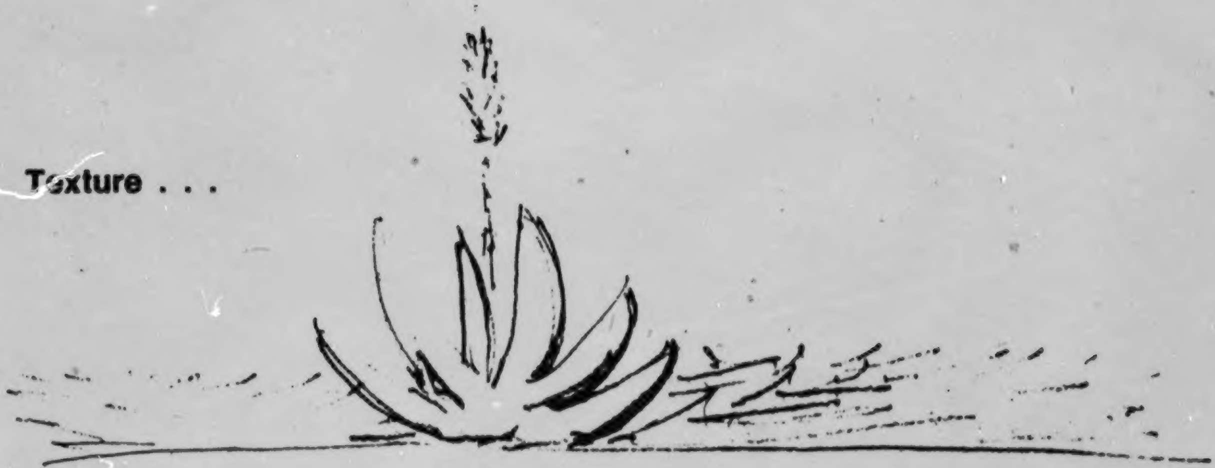
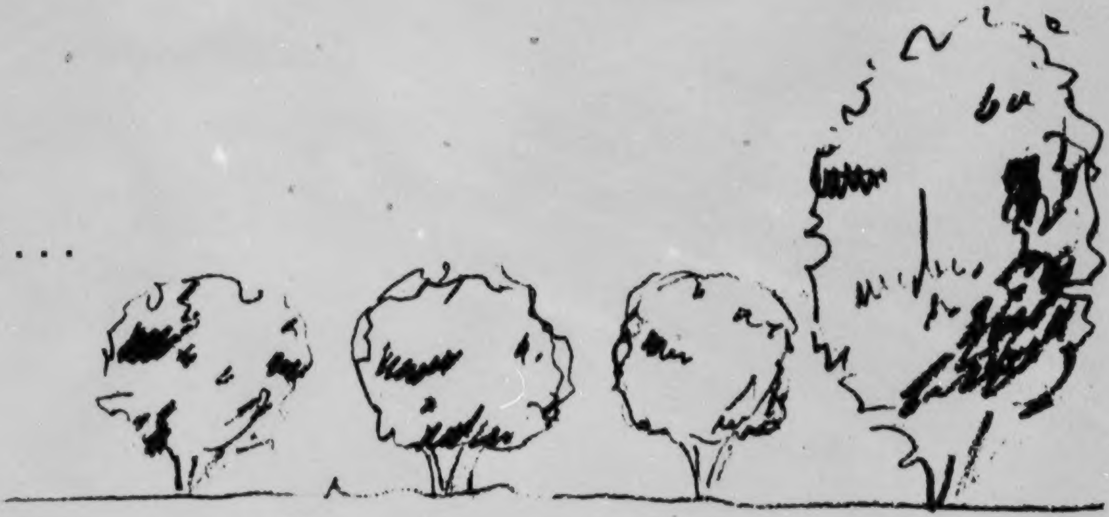
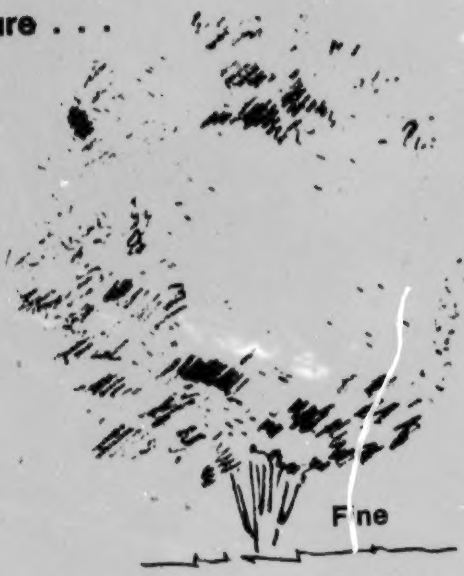
Texture . . .

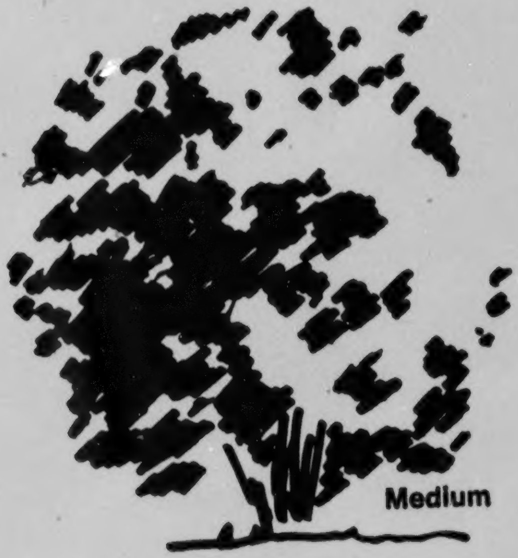


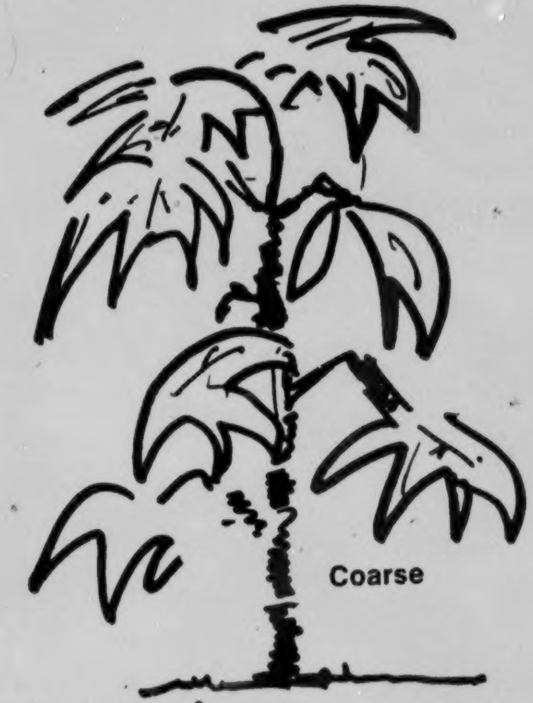
Size . . .



Texture . . .







Things to do before lesson three . . .

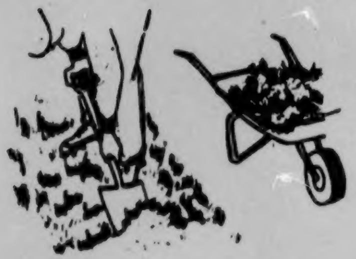
1. Go back over your check-list and see if any new items or use areas need to be added.
2. Look at trees near you and decide which ones you like and which ones you don't care for.
3. Look at patios, decks, fences, benches, water features, and lighting and decide if any or all of these are to be included in your plan.
4. Make notes of items you want to remember below.

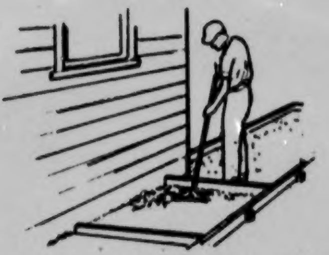
*5. Re-draw your plan with the property lines and the outline of your house at a scale of 1"=10'-0" on it. Do this on a single sheet of 18" x 24" vellum paper. Leave room on your sheet on the right-hand side for notes and at the bottom for your title block.

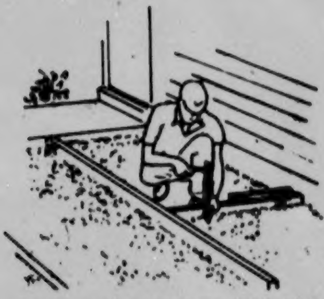
- * Your leader will have an example of how this is to be done.

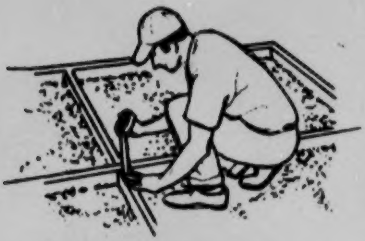
Additional helps

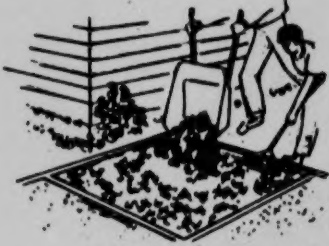
HOW TO CONSTRUCT A CONCRETE PATIO

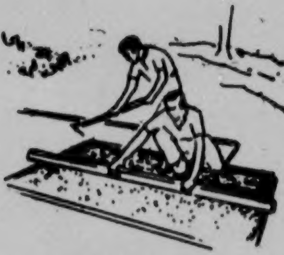

Remove sod and soil from area to be paved. Use tamper to compact the soil and make it fairly even and smooth.

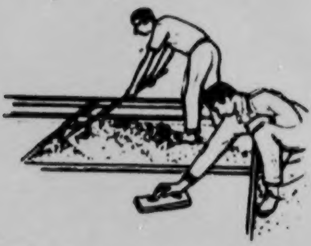

Secure edgings by driving stakes slightly lower than height of edgings and nailing securely with galvanized nails.

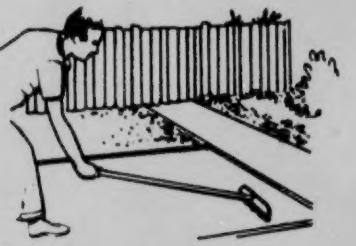

Spread sand evenly to a depth of 2 inches over the area. Dampen the sand using a fine spray to help it settle completely.

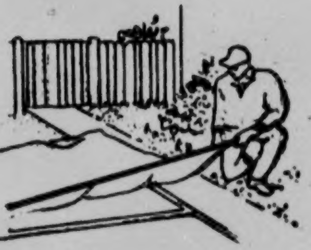

Cover dividers that are to be left in place with a layer of masking tape before pouring the concrete. Leave stakes in place.


Pour concrete into one section at a time. Space or rake the concrete well into the corners; overfill the forms slightly.


Use straightedge to strike-off concrete so that it is level with height of forms, but don't try to get a smooth surface.

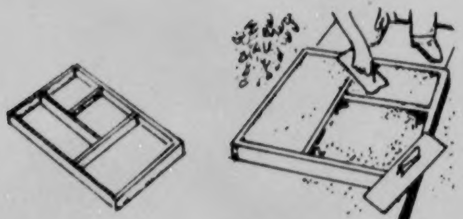

Trowel concrete using a wooden float, which gives it a rough surface. Use a **steel trowel** for a denser smooth surface.

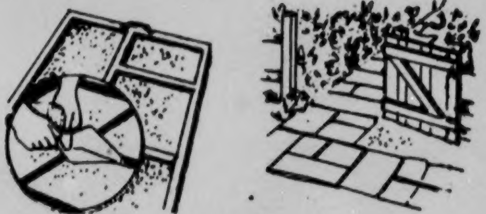

Use broom with fine bristles to produce interesting texture, cut down surface glare, and provide good traction.


Cover with plastic weighted at the edges to seal in moisture of curing. Keep surface covered for at least five days.

Courtesy of Portland Cement Assc.

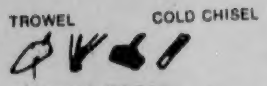
HOW TO MAKE PRE-CAST STEPPING STONES


Wood frame is easy to build, has common wire handles on ends. Work concrete mix into form with trowel, then strike off the surface with a wood float, giving it a rough, non-skid texture.

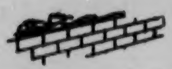

Lift form gently off concrete after it has set up slightly. Use two trowels to edge around each paver; keep concrete damp for several days. Completed walk has a modular pattern.

WALLS...

BRICK

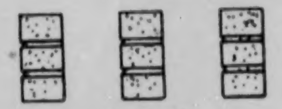

TROWEL
COLD CHISEL

LAYING TOOLS

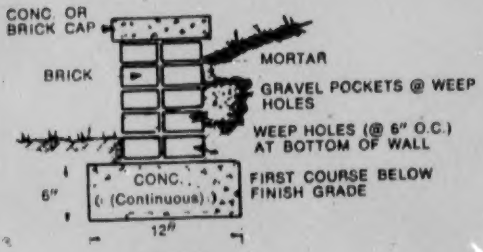


SPREADING MORTAR

FURROWING



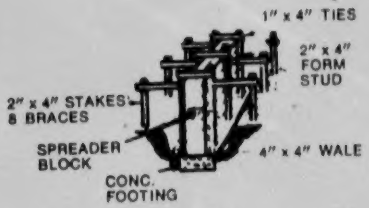
STRIKING MORTAR JOINTS


CONC. OR BRICK CAP
BRICK
MORTAR
GRAVEL POCKETS @ WEEP HOLES
WEEP HOLES (@ 6" O.C.) AT BOTTOM OF WALL
CONC. (Continuous)
FIRST COURSE BELOW FINISH GRADE
6"
12"

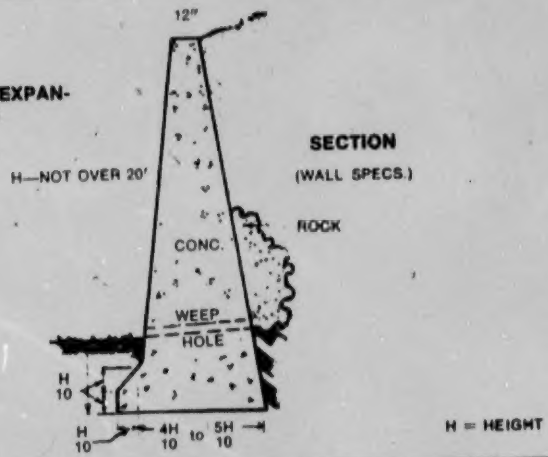
SECTION

CONCRETE

PLAN-KEYED WALL EXPANSION JOINTS


1" x 4" TIES
2" x 4" FORM STUD
2" x 4" STAKES & BRACES
SPREADER BLOCK
4" x 4" WALE
CONC. FOOTING

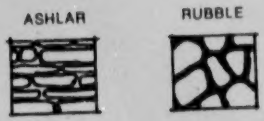
WALL FORMING


12"
H—NOT OVER 20'
ROCK
CONC.
WEEP HOLE
H/10
H/10
4H/10 to 5H/10
H = HEIGHT

SECTION

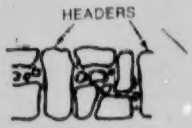
(WALL SPECS.)

STONE


ASHLAR
RUBBLE

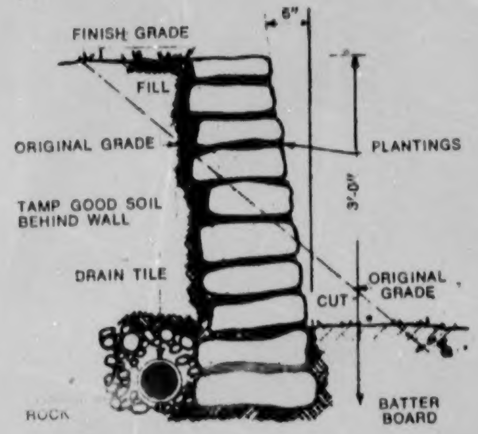
TYPES OF STONEWORK

SECTION



TOP VIEW

CONSTRUCTION METHODS


FINISH GRADE
6"
FILL
ORIGINAL GRADE
PLANTINGS
3'-0"
TAMP GOOD SOIL BEHIND WALL
DRAIN TILE
CUT
ORIGINAL GRADE
ROCK
BATTER BOARD

SECTION-DRY WALL

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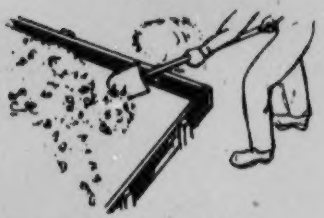
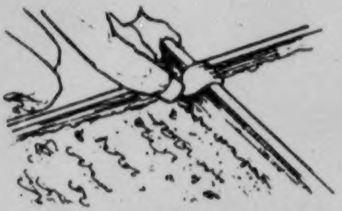
HOW TO LAY BRICKS IN DRY MORTAR

Almost everyone who has tackled the job of laying bricks has some opinions on ways to make the job easier. If you are a beginning bricklayer, it is a good idea to talk to friends and neighbors who have worked with brick and who may have some helpful suggestions. Don't be in too big a hurry to start laying the brick.

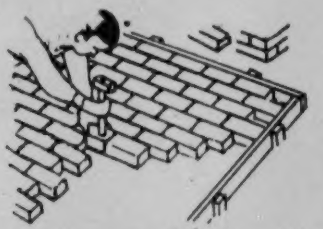
Take time to experiment with various patterns and grid sizes before you begin. As a helpful guide, the six sketches below offer a step-by-step procedure for laying bricks in dry mortar. Most of the operations also apply to laying bricks over existing concrete, in sand, and in wet mortar.



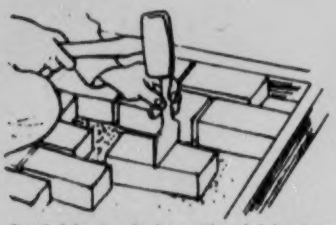
Spread sand between edgings to a depth of 1 to 2 inches. Then wet the sand with a fine spray to help it settle.



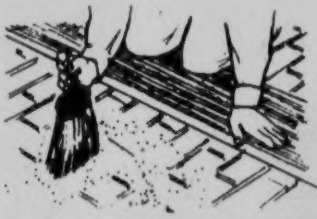
Screed sand about 3 feet at a time. Once bricks are in place, screed next 3 feet; set bricks even with those already laid.



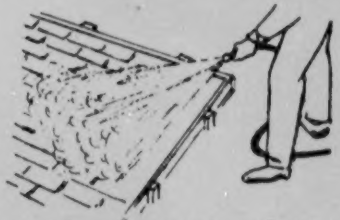
Work forward from bricks already laid. Here bricks laid running bond are tamped into place with the handle of a mallet.



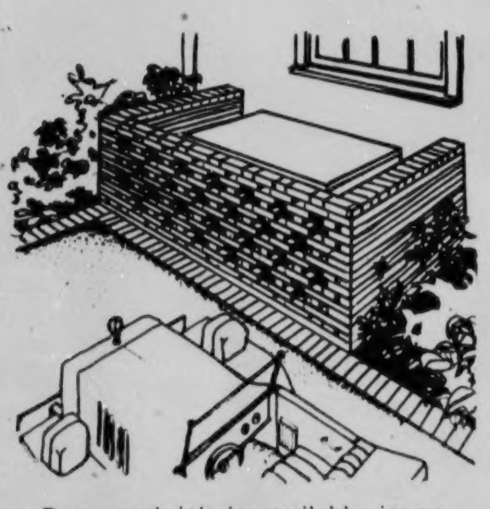
Cut bricks for fit by setting brick on sand, holding wide chisel in place, and using heavy mallet to give chisel a firm tap.



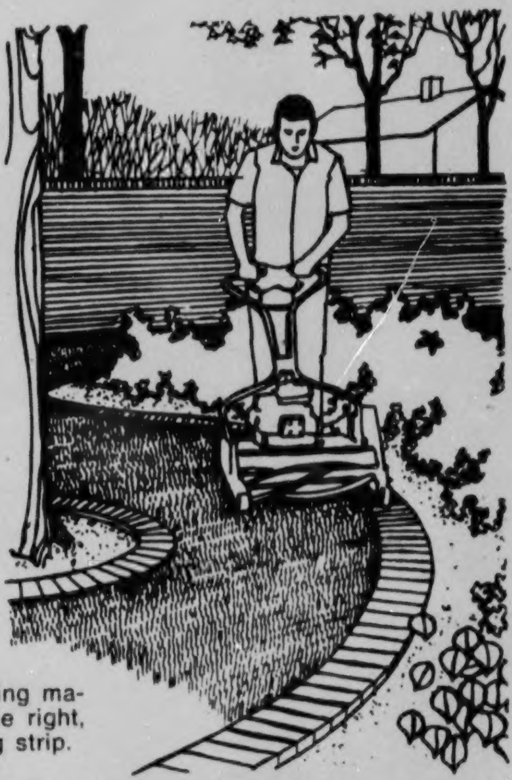
Use hand brush to sweep dry mortar into ½-inch separation between bricks; sweep away excess with hand or push broom.



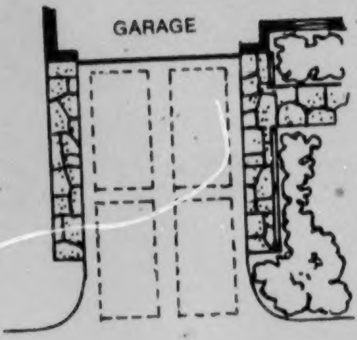
Use fine spray to wet area, being careful not to wash mortar out of joints. Let mortar set 2 hours before scrubbing bricks clean.

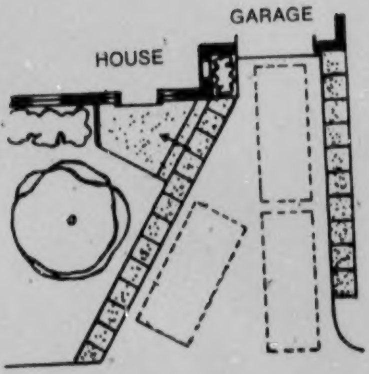


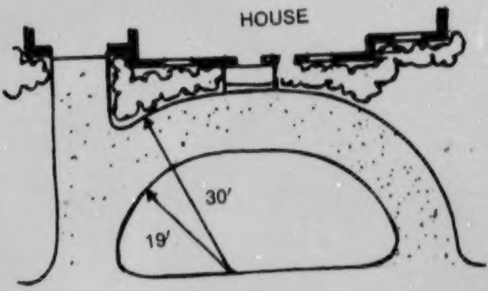
Because brick is available in so many colors, and textures it can be effectively used to help define a space. It may also be used to conceal an air conditioner.

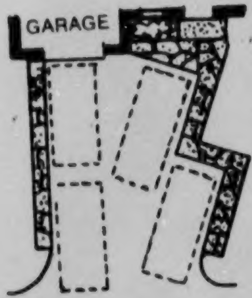


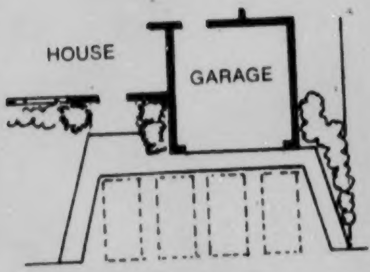
Bricks make excellent edging material. In the drawing to the right, they are used as a mowing strip.

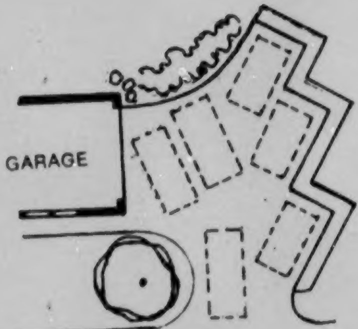

GARAGE

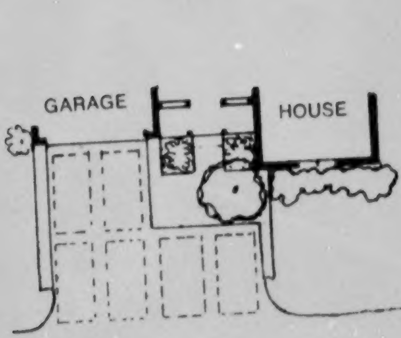

GARAGE
HOUSE

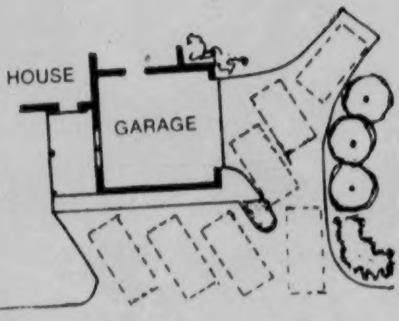

HOUSE
30′
19′


GARAGE

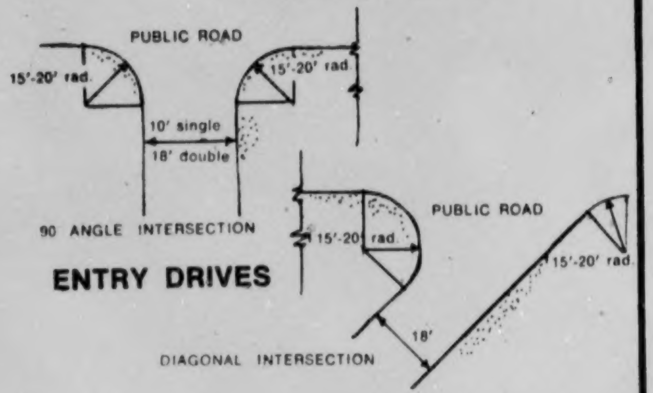

HOUSE
GARAGE


GARAGE

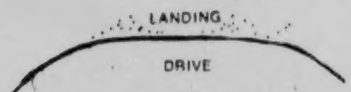

GARAGE
HOUSE


HOUSE
GARAGE

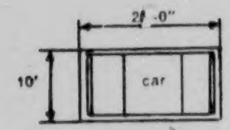
PRIVATE ROADS


PUBLIC ROAD
15'-20' rad.
15'-20' rad.
10' single
18' double
90 ANGLE INTERSECTION
PUBLIC ROAD
15'-20' rad.
15'-20' rad.
18'
DIAGONAL INTERSECTION

ENTRY DRIVES

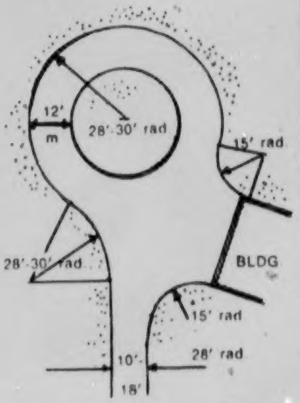

LANDING
DRIVE

NO CURVES AT LANDINGS



CAR NEEDS

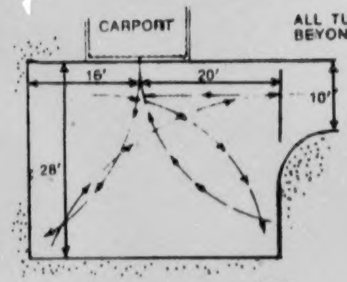
SHOWN IS MINIMUM SPACE REQUIRED FOR AN AUTO


12'
m
28'-30' rad
15' rad
BLDG
28'-30' rad
15' rad
28' rad
10'
18'

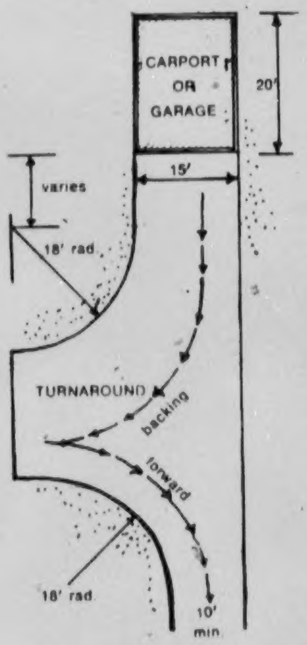
TURN AROUND

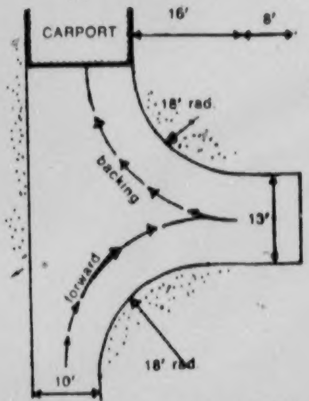
GARAGE DRIVES

ALL TURNS REQUIRE 2'-0" CLEARANCE BEYOND EDGE OF SURFACING


CARPORT
16'
20'
10'
28'

DOUBLE "Y" LIMITED SPACE

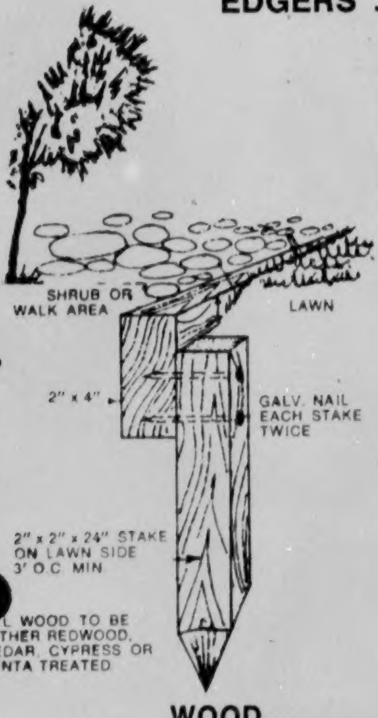

CARPORT OR GARAGE
20'
15'
varies
18' rad
TURNAROUND
backing
forward
18' rad
10' min.


CARPORT
16'
8'
18' rad
backing
13'
forward
18' rad
10'

"Y" TURN BACK-IN

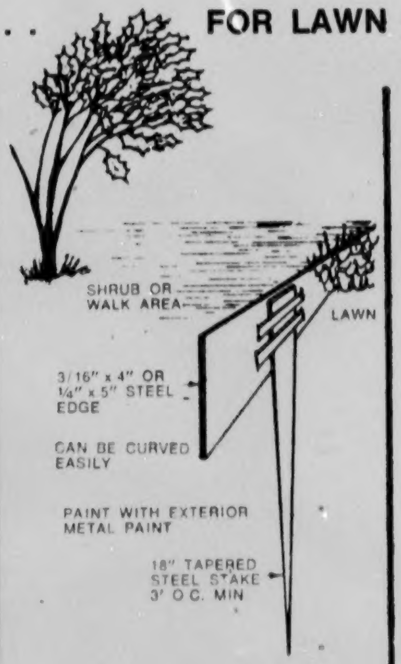
"Y" TURN BACK-OUT

EDGERS . . . FOR LAWN & SHRUBS

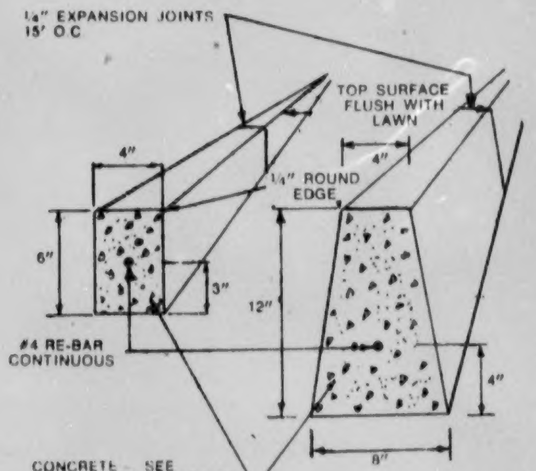

SHRUB OR WALK AREA
LAWN
2" x 4"
GALV. NAIL EACH STAKE TWICE
2" x 2" x 24" STAKE ON LAWN SIDE 3' O.C. MIN

L WOOD TO BE EITHER REDWOOD, CEDAR, CYPRESS OR PENTA TREATED

WOOD


SHRUB OR WALK AREA
LAWN
3/16" x 4" OR 1/4" x 5" STEEL EDGE
CAN BE CURVED EASILY
PAINT WITH EXTERIOR METAL PAINT
18" TAPERED STEEL STAKE 3' O.C. MIN

STEEL


1/4" EXPANSION JOINTS 15' O.C.
TOP SURFACE FLUSH WITH LAWN
4"
4"
1/4" ROUND EDGE
6"
3"
12"
#4 RE-BAR CONTINUOUS
4"
8"
CONCRETE - SEE FORMULA ON "EXTERIOR HARD SURFACES" SHEET

EXPOSED SURFACES TO HAVE LIGHT BRUSH FINISH

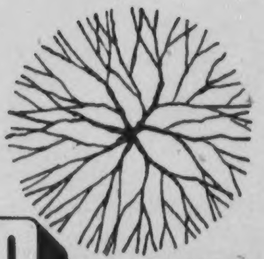
STANDARD **TAPERED**

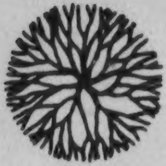
707

CONCRETE

HO-113

Landscaping at Home



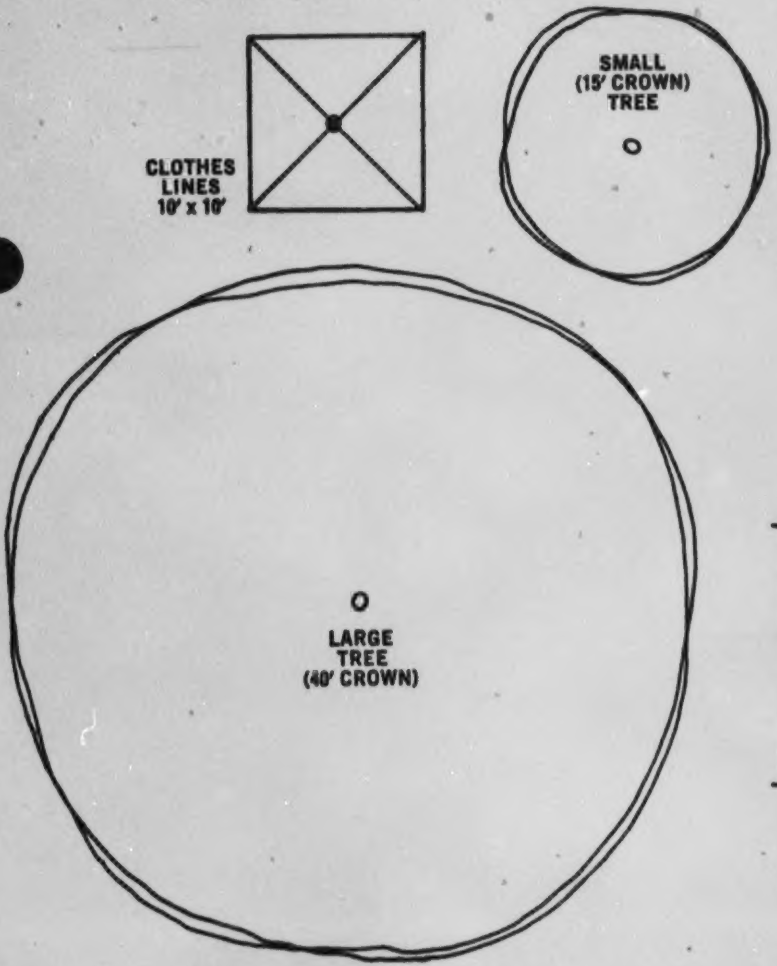
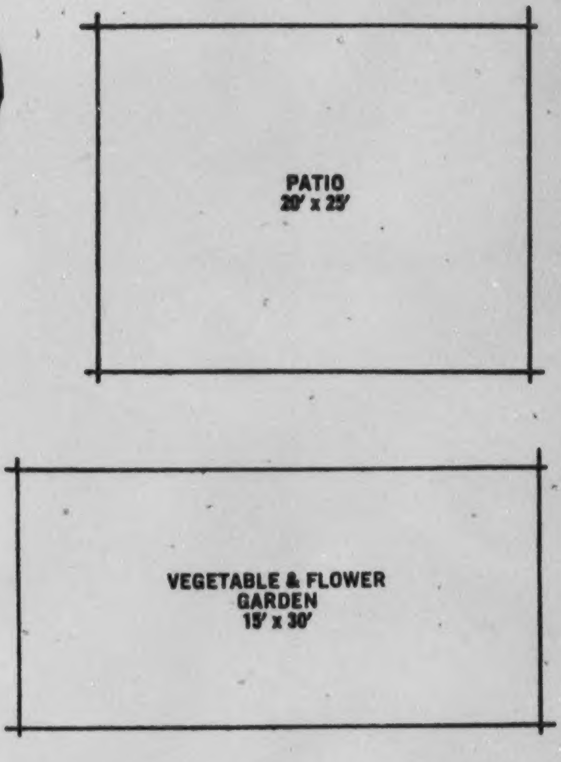


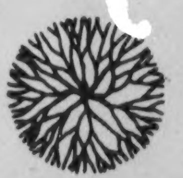
HORTICULTURE DEPARTMENT
COOPERATIVE EXTENSION SERVICE
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

Making final plans

Before finalizing your plan, consider the following:

1. Each feature you have planned for your home will require space on your property. You can expedite your planning if you will draw each element in plan view at the final scale: 1"=10'-0". Here are some examples:





7)8

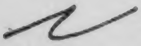
by Lawrence B. Zuercher, Landscape Architect

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

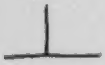
2. The Patio. To be adequate, your patio should provide between 80 and 120 square feet of surface per person in your family. A common tendency is to build this area too small for heavy outdoor use such as dining and entertaining.

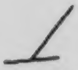
When the edge of the patio is to be curved, locate the curve so that the widest point coincides with the area of greatest use. Do not arbitrarily design the shape of your patio; instead shape the edge of the patio so it complements, repeats, and/or harmonizes with other lines in your outdoor living space. If the line formed by the outside edge of your patio is curving, then part of your lawn edge should also be curving. If a shrub border line is angular, then the patio should be angular.

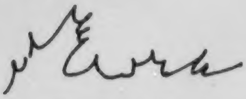
An additional consideration is for you to determine what mood you want to set with your patio and living area. Every line evident in the form or surface of any element, or that is described by the meeting of any forms or walls has its own design expression. This expression must be in harmony with the intended mood of the space. A graphic demonstration of some variations is given below:

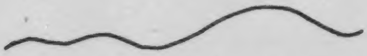

Active

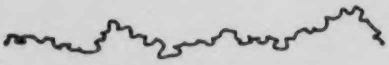
Passive


Stable


Unstable


Flamboyant


Curvy, tender, soft, pleasant, femine, beautiful.


Rough, rasping, grating

In motion

If you design your new patio to make a rectangle or square, this will, of course, influence the form and direction of other lines in that area.

Be sure to provide for some shade on at least a portion of the patio. If your patio is located so the sun's heat rays bounce off the patio surface and into the house through windows or sliding glass doors in summer the patio will need to be covered or shaded to counteract the sun.

On the east or south side of your house, a patio roof or an overhead trellis with pole supports works well. A well placed, deciduous tree can overhang the patio and it will provide the needed shade.

On a west patio, you will need an overhead covering, and shade from the setting sun. In the late afternoon when the sun is very intense, it can shine under overhead structures. These almost vertical rays need to be broken by vertical elements such as columnar trees planted back from and to the west and west-northwest side of the patio.

Patio surfaces vary. The cost of materials, cost of installation, and how it will be used may influence your choice. Sometimes a patio can have a multiple use. Sand piles can be built into the edge and later converted into a pool, a planter, a firepit, or a storage space with a little extra construction.

3. Now is the time for you to conceptualize your plan and mentally place the elements. Begin as though you were entering your home site from the front and walk yourself around while you mentally paint the picture. Record your trip on the following page. If you need help getting started, you will be interested in the following example of how one family recorded their plan:

One family's experience

The first thing we notice is that the drive is wide and inviting and we have no trouble finding a place to park our car. As we start toward the front door, we notice that the sidewalk has changed from concrete to brick, which blends well with the used brick of the front of the house. The shrub bed near the entrance is enlarged and a small tree provides some welcome shade. We glance to the north of the garage and see that the sidewalk is concrete and is wide enough to permit trash removal and delivery service.

We walk through the house and peer out the wide window in the dining room. From inside, the drapes frame a delightful vista in the corner of the yard and the trees and shrubs in the yard seem to frame the setting.

We walk out into the back yard. A wooden screen using the same wood as the exterior of the house visually divides our living area from the service area. The fence has a jog at the corner to allow convenient passage, while still providing the visual barrier. That fence makes a good background for the flowers planted in front of it. Our eyes follow the fence to an outdoor storage structure. The structure is at one end of the patio and provides for storage of the grill, patio furniture, and some lawn and garden tools. It makes a wonderful barrier for the late afternoon sun which is blocked as the rays come under the large tree located about 30 feet behind the storage unit.

We walk on to the patio and sit down in the lawn swing and drink our lemonade. We remark that even at mid-day it is comfortable here because of the overhead trellis and vines. The trellis seems to extend the house into the yard. Those annuals really provide a splash of color. We find we are attracted out along the flowing line of the flower bed to take a closer look.

Our eyes follow the wooden fence structure to the south. The fence provides the privacy we wanted from our neighbors. We were going to put in a shrub barrier as a screen, but we decided to continue with the fence since the space is narrow and the shrubs would take some time to equal the wood fence in privacy.

The fence is turned toward the patio as it passes the east side. We're not much for garden statuary, but last summer on our trip to California we couldn't resist a piece of sculpture. Now it looks perfect in the setting created by the enclosure of the fence.

We walk out back to our vegetable garden. We made the mowing strip three bricks wide so it would double as a walk way. The brick fit so well with the brick of the house, really makes the whole thing tie in together. Our vegetable garden is located to the north of the clothes lines in the service area. We changed these two after the first summer because the prevailing winds from the south kept blowing dust on freshly washed clothes.

I guess one of the things we enjoy most about our yard is how nice it looks during the day and how much we enjoy it at night since we installed the lighting system. That front entrance light makes those stairs safe now and the low level lighting in the shrub beds really emphasizes their interesting branching structure. Having the patio lights put on a dimmer switch was a real stroke of genius. I remember the dinner party we had and how nice it was to use the low level lights to make the patio setting a perfect background through the sliding doors. We sure needed the lights up when we had the group over for that watermelon feed. I guess the low level lights in the shrub beds and over the flowers are my favorite. It was a good idea to put the various lights on separate switches so we can alternate the effects. Sometimes I like to turn all the other lights off and only turn on the uplight in the multi-trunk tree, especially in winter.

Write your conceptual plan here

Make no small plans. Plan for the ideal yard—much can be accomplished by phasing the plan.

711

Completing your master plan

Now it's time to locate and draw trees and shrubs on your plan. Fasten a piece of tracing paper or vellum over your full size site layout plan.

Locate and draw deciduous trees for shade, framing and background. Plant to shade the southwest, south, and southeast sides of the yard and house. Plant shade for the patio. Be sure to place these trees 15 to 25 feet from the house or any overhead wires, and 4 or 5 feet from walks, retaining walls, drives and patios. Draw a circle indicating the full mature size of the tree spread as well as the location of the trunk. Most shade trees spend the majority of their years with a foliage spread of 20 to 30 feet. Some trees, however, may reach a spread of 60 to 80 feet at maturity. Check the plant listing included with this lesson or check with your local nurseryman to be sure of a tree's ultimate size.

As you select your trees and shrubs, consider the following factors:

1. Is the plant adaptable to your area?
2. What size plant do you need?
3. What shape plant do you want?
4. What foliage color and texture do you want?
5. When do you want the plants to bloom?
6. What flower or fruit color do you want?
7. Are you needing a plant that can be planted in the shade or in full sun?

After you have located your trees, and using the same piece of tracing paper or vellum, locate individual shrubs, small trees, and flower beds in your plan.

Draw large shrubs for a spread of 6 to 8 feet, medium shrubs 4 to 6 feet, and small shrubs 2 to 4 feet. Draw small trees with crown spreads of 10 to 15 feet.

Draw pyramidal evergreens, such as untrimmed upright juniper, with a spread of 8 to 12 feet.

Completely fill the shrub border soil bed with shrubs and flowers. Always draw shrubs with a crown spread equal to their mature size.

After you have completed your planting plan, review it to be sure you are satisfied with your choices. If not, change them. When you are satisfied with your plan, transfer it to a final copy drawn on vellum. Label plants and elements accordingly on the final plan. An example of a completed plan can be found at the end of this lesson.

Your completed landscape plan is a valuable document. It is advisable to secure several prints of your plan. Most engineering firms, architects, and landscape architects have printing machines and will gladly run copies of your print for a nominal charge. Often city and county offices have machines also and can provide that service for you.

Your plan is a master plan for future development as you see it today. It is much like a budget in that it provides a guideline for the future. If your family desires change or you need something in the future that you failed to consider now, you may want to modify this original plan. Never let this plan box you in and eliminate other alternatives.

One particularly desirable feature of having a master plan is that if you don't have enough money to complete the entire plan now you can "Phase" the development over time. If you decide to take that route, consider the following:

1. Plant trees for shade first since they need growing time to develop.
2. Determine how much you can afford each year and decide which items you most want first. Then develop your plan accordingly.
3. Always try to complete enough of what you do each year so the plan appears complete.

YARD & GARDEN
HORTICULTURE DEPARTMENT • COOPERATIVE EXTENSION SERVICE • PURDUE UNIVERSITY • WEST LAFAYETTE, INDIANA 47907

HO-101
1978

RECOMMENDED VEGETABLE VARIETIES

John A. Wott, Extension home environment horticulturist and Juliann Chamberlain, Extension assistant in horticulture

"What vegetables should I raise this year? Shall I try something different? Which varieties are best? Where will I be able to find seed of the newer varieties? This publication answers some of these most often asked questions.

Many vegetables are started from seed, but certain kinds, such as asparagus and rhubarb, are propagated by crowns and roots. Still others, such as broccoli, cabbage, cauliflower, eggplant, peppers, and tomatoes, are more conveniently started from transplants than from seed. Onions may be started from "sets," from seed or from "slips" (small plants). Strawberries should be started from plants.

Generally, seeds and plants can be purchased from local garden supply centers, plant growers, greenhouse operators and grocery and hardware stores. With newer varieties or unusual types, however, seed and plants may not always be available locally. For this reason, a general listing of seed and plant sources is included at the end of this publication. Companies will be glad to supply catalogs and price lists upon request. Order early to insure the availability of varieties of your choice.

Where spraying or dusting is suggested, use an "all-purpose" garden dust or spray containing an insecticide plus a fungicide. Weekly application *plus* an application after each rain gives the most desirable results. Always follow the directions on the label. Note especially any harvest restrictions.

Asparagus

A very early spring vegetable that comes up year after year. It's good for home freezing and tall enough to serve as a hedge in summer. Wait two years before cutting the first crop of spears. Plant roots rather than seeds for an earlier first crop.

Variety	Source*	Disease Tolerance	Other
Mary Washington	BP/FS/HF/CH	Rust	
Paradise	PA/BU		

---

*Sources for seeds and plants listed in this publication are intended only as a general guide for the public, and it is not intended to be an all-inclusive listing.

*Sources listed on page 12.

Green Snap Beans

Easy to grow. These beans are good for home freezing or canning. They are killed by frost. Bush snapbeans are fast-growing and medium-tall. Dust or spray to control bean beetles, which chew round holes in the leaves.

Variety	Source	Disease Tolerance	Other
Executive (AAS)*	ST/NK	Mosaic	
Greencrop (AAS)	ST/BP/HF		
Greensleeves	BP/CH	Mosaic	
Harvester	ST	Mosaic	
Provider	ST/FM	Powdery mildew, mosaic	Good yield under adverse conditions
Tendercrop	ST/BP/PA/FM	Mosaic	
Tendergreen types	ST/PA/HF	Mosaic, bacterial wilt, rust	
Tenderpod (AAS)	ST		
Top crop	ST/PA/FS	Mosaic	

Yellow Wax Beans

Color is the biggest difference between these and green snap beans. Use them fresh or for canning and freezing.

Variety	Source	Disease Tolerance	Other
Cherokee Wax	ST/FS	Rust	
Goldcrop (AAS)	ST/BP/PA/FM	Curly top virus, mosaic, blossom drop	Straight, long pods
Kinghorn Wax	ST/CH/FM		Excellent quality

Pole Snap Beans

Can be grown on fence, trellis or poles set in a tripod. Good for gardeners with limited space.

Variety	Source	Disease Tolerance	Other
Blue Lake	ST/CH		Good for freezing and canning
Kentucky Wonder	ST/BP/PA HF/CH	Bacterial blight, mosaic, rust	

Lima Beans

Limas can be frozen or canned. Of medium height, this vegetable can't take frost or very hot weather.

Variety	Source	Disease Tolerance	Other
Fordhook 242 (AAS)	ST/BP/PA/HF	Downy mildew	Large seeded, heat tolerant
King of the Garden	ST/PA	Downy mildew	Pole lima

Soybeans

Green pods can be harvested and boiled or baked as lima beans. Soybeans can be dried and roasted for high protein food.

Variety	Source	Disease Tolerance	Other
Fiskeby V	ST		

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*Note the code name AAS, which appears for many of the varieties listed here, indicates "All American Selection," an honor voted by judges of the American and Canadian Seed Trade Associations to the top varieties of selected plants.

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Beets

Easy to grow. Beets are low-growing, high-yielding and require little space. They prefer cool temperatures and can withstand frost. Store them for winter use in a cool, moist place.

Variety	Source	Disease Tolerance	Other
Detroit Dark Red	ST/PA/HF/BU	Downy mildew, boron deficiency tolerant	
Monogerm	ST		Similar to Detroit types but no thinning required
Ruby Queen (AAS)	HA/FS/NK/FM		Superior quality

Broccoli

Increasing in popularity, this vegetable has a large center head which develops first. After the plant is cut initially, numerous branch heads develop.

Variety	Source	Disease Tolerance	Other
Cleopatra (AAS)	PA/HM		Cold and drought resistant
Green Comet (AAS)	ST/FS/BA/GA	Yellows	Heat resistant, early
Premium Crop (AAS)	ST/PA/VJ/CH/GE		No side shoots after first cutting One harvest
Spartan Early	ST/HF		Early
Waltham 29	ST/VJ		late season harvest

Brussels Sprouts

This cool season vegetable can be used as a fall vegetable in hot areas. Where winters are mild, it may survive for a longer harvest period.

Variety	Source	Disease Tolerance	Other
Jade Cross (AAS)	ST/PA/HM/VJ BA/GE		Twice the number of sprouts of other varieties

Cabbage

This medium-height, frost-hardy vegetable matures at different times of the year, depending on the variety. Start from plants. Spray or dust to protect new plants from cutworms and similarly treat growing plants for green cabbage worms. Store where cool and moist or make into kraut. Plant varieties which are yellows resistant.

Variety	Source	Disease Tolerance	Other
Autumn Marvel	ST	Yellows	
Golden Acre	BP/FS/HF/FM	Yellows	Early
Harvester Queen (AAS)	PA/VJ		
Red Acre	ST	Yellows	Red color
Red Head (AAS)	ST/GA	Yellows	Red color
Roundup	ST	Yellows	Good for kraut
Ruby Ball (AAS)	BP/BA/GE		
Savoy Ace (AAS)	ST/BP/PA/CH/BU	Yellows	Crinkled leaf
Savoy King Hybrid (AAS)	BP/BA		More delicate flavor than regular cabbage crinkled leaf
Stonehead (AAS)	ST/PA/HM/GE/NK	Yellows	Early

Cantaloupe (muskmelon)

This vine crop needs lots of space, and is not suitable for small gardens. It grows well only in warm weather and is killed by frost. Spray or dust to control aphids and beetles that carry bacterial wilt and leaf diseases.

Variety	Source	Disease Tolerance	Other
Burpee Hybrid	BP/HM/GE		Good flavor
Harper Hybrid	HA/BA	Fusarium, alternaria blight	Holds good quality after picking
Harvest Queen	ST		Late
Honeyrock (AAS)	ST/GA/FM		
Pride of Wisconsin	BP/GA	Bacterial wilt, alternaria blight	
Saticoy Resistant	ST	Fusarium, mildew, fruit spot	
Supermarket	HA/VJ/GE/NK		High yield
Early Dawn	HA	Downy mildew, fusarium	Extra early

Carrots

These low-growing, high-yielding and frost-hardy vegetables require little garden space and are popular for home canning. Store them fresh only where it is cool and moist.

Variety	Source	Disease Tolerance	Other
Nantes	ST/BP/GH/NK/BU		
Royal Chantenay	ST/BP/HF		
Spartan Classic	ST	Rusty root, leaf blight	
Spartan Premium	ST	Rusty root, leaf blight	

Cauliflower

Weather conditions have a great influence on the growth of the vegetable. Heat can destroy plants with stem rot while dry weather can cause plants to bolt. Take care that transplants do not dry out prior to planting as the plants will become hard and growth will be unsatisfactory.

Variety	Source	Disease Tolerance	Other
Dominant	ST		Withstands heat and drought well
Early Snowball	BP/FS/CH	Yellows	
Self Blanche	ST/PA/BA		In cool weather, leaves wrap around head to maintain whiteness
Snow Crown (AAS)	ST/BP/PA/BA/NK		
Snow King Hybrid (AAS)	BP/PA/HM/GA		

Chinese Cabbage

This is a fast-maturing 'celery substitute'. Easy to grow.

Variety	Source	Disease Tolerance	Other
Burpee Hybrid	BP		Green, savoyed leaves
Michili	BP/HF		Keeps well

Celeriac

Large, thick root is edible. Good in soup, boiled, or raw. Roots may be stored.

Variety	Source	Disease Tolerance	Other
Alabaster	BP		Flavor similar to celery

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Celery

Plant outside when nights are warm. Keep plants well watered for optimum growth.

Variety	Source	Disease Tolerance	Other
Cornell 619	ST	Yellows	
Golden Self-Blanching	BP/HF/BA/CA	Tolerant to boron deficiency	Good quality, yellow celery
Utah Strains	ST/FS/HM/FM	Tolerant to boron deficiency, Fusarium	

Collards

Plants will withstand light freezing. Can be sown for a fall crop.

Variety	Source	Disease Tolerance	Other
Vates	ST/PA/GE/FM		Excellent greens

Cucumbers

This vine crop may be grown on a fence or trellis in small gardens. Grows best in warm weather and is killed by frost. The grower must dust or spray to control beetles that carry wilt disease.

Variety	Source	Disease Tolerance	Other
The following varieties are recommended for pickling:			
Liberty (AAS)	ST	Scab mosaic, downy and powdery mildew, angular leaf spot, target spot	Pickling
Patio Pick	ST/HF/VJ/GA	Powdery-downy mildew, scab	Pickling
Pioneer	ST/CH/GA	Scab, mosaic, downy-angular leaf spot	Less tendency to form, misshapen fruit, pickling
SMR 58	HA	Scab, mosaic	Pickling
Spartan Dawn	ST/PA/BU	Scab, mosaic	Pickling
The following varieties are recommended for fresh use:			
Burpee Hybrid	BP/HM	Mosaic, downy mildew	Slicing
Gemini	ST/PA	Scab, anthracnose, downy and powdery mildew	Slicing
Marketer (AAS)	BP		Slicing
Marketmore	ST/BP	Scab, mosaic	Slicing
Marketmore 70	ST/BA	Scab, mosaic	Slicing
Meridian	ST	Scab, mosaic	Slicing
Burpee's M & M Hybrid	BP	Downy mildew, mosaic	Slicing
Pacer	HA	Scab, mosaic	Good in northern regions, slicing
Poinsett	HA/FM	Downy and powdery mildew, angular leaf spot, anthracnose	Slicing. Good in southern regions
Saticoy	ST	Mosaic, downy mildew	Slicing
Spartan Valor (AAS)	ST/CH/BU	Scab, mosaic	Slicing
Stokes Early Hybrid	ST	Downy mildew, mosaic	Slicing
Straight Eight (AAS)	BP		Slicing
Surecrop (AAS)	PA		Slicing
Sweet Slice	ST/HM/GA	Anthracnose, angular leaf spot, scab, mosaic, powdery and downy mildew	Bitter-free, slicing, burpless
Tablegreen 65	ST	Scab, mosaic, powdery and downy mildew	Slicing
Victory (AAS)	ST/BP/GE/HM/NK	Scab, powdery and downy mildew	Slicing

Eggplant

Here we have a warm-season plant of medium height which will not take frosts. Start it from plants. Insects are a problem, especially cutworms on new plants and lace bugs and flea beetles on growing plants. Spray or dust for these and for leaf spot diseases.

Variety	Source	Disease Tolerance	Other
Burpee Hybrid	BP		Drought-disease resistant
Early Hybrid	ST/BP	Fusarium	

Endive

This leafy vegetable resembles lettuce in its growth requirements, but is less sensitive to heat.

Variety	Source	Disease Tolerance	Other
Batavian Full Heart	ST/CH/GA		
(AAS)	ST		
Salad King	ST/GE/BU		Heat tolerant

Kale

Variety	Source	Disease Tolerance	Other
Dwarf Blue Curled Vates	BP/GE/FM		High in vitamins A and C

Kohlrabi

Variety	Source	Disease Tolerance	Other
Early White Vienna	ST/BP/FS/HM/CH		White flesh
Early Purple Vienna	ST/BP/FS/CH/NK		Green flesh

Lettuce

Most people are quite fond of this popular home garden vegetable. Both the loose-leaf and loose-head types are low-growing, high-yielding and fast growing, and require little space. Lettuce does fairly well in part shade, likes cool weather, and will survive frost.

Variety	Source	Disease Tolerance	Other
Black Seeded Simpson	ST/BP/FM	Early looseleaf type	
Buttercrunch (AAS)	ST/BP/HF/GE		Bibb lettuce, slow to bolt. Not bitter after seeds form
Butter King	ST/GA		Slow to bolt. Heat resistant
Grand Rapids	ST/BP/HM/BA	Mildew	Looseleaf type
Oak Leaf	BP/GA/BU		Looseleaf type, heat resistant
Ruby (AAS)	BP/HF		Red leaves
Salad Bowl (AAS)	BP/FS/NK	Looseleaf	
Slobolt	HA		Looseleaf, tipburn resistant
Summer Bibb	HA		Looseleaf, slow to bolt, tipburn resistant
White Boston	ST/FM	Root rot	

Mustard

Mustard is used as a green or salad vegetable.

Variety	Source	Disease Tolerance	Other
Tendergreen	BP/HF/FM		Heat and drought resistant

Okra

Planning to use okra in soups, gumbos or stews? Fried? Try this vegetable.

Variety	Source	Disease Tolerance	Other
Clemson Spineless (AAS)	BP/CH/ FM/BU		

Onions

This vegetable is used green in the spring, or grown all summer to make dry onions for fall storage. The onion is a low-growing, high-yielding plant that requires little space. It is killed by frost, and is best grown from "sets" (small bulbs). Store dry onions in a cool, dry place.

Variety	Source	Disease Tolerance	Other
Early Yellow Globe	ST/BP/FS/BU		
Ebenezer	ST/BP/PA		
Evergreen	BP/BA	Smut, pink root	Bunching
Southport Red Globe	ST/BP/VJ	Fusarium, bulb rot	Good in storage
Southport White Globe	ST/FS/CH		
Spartan Sleeper	ST		Good in storage, few sprouts
Stuttgarter	HB		Plant onion sets. Keeps well.

Parsley

Variety	Source	Disease Tolerance	Other
Darkii	ST		
Paramount (AAS)	PA/FM		

Parsnip

Plant parsnips as soon as the soil can be worked in the spring. They require 105-110 days to mature. Handle them like other root crops, such as beets and carrots. Keep soil ridged up over the crowns to prevent greening. Water the planted area every five days until the parsnips emerge. These vegetables may be stored over winter in ventilated plastic bags at 32-40° F., or you may leave them in the ground, since they will not be damaged.

Variety	Source	Disease Tolerance	Other
All-America	HA/HF		Early
Model	HA/FM	Root canker	Smooth, white root

Peas

Available in either a low-growing type or vine type (which will climb 3-foot wires), peas are fine for both canning and freezing. They grow best in cool weather and are tolerant of frosts. Peas must be planted in very early spring.

Variety	Source	Disease Tolerance	Other
Freezonian	BP/PA/HF/BU	Fusarium	
Green Arrow	ST/BP/HF	Fusarium, downy mildew, leaf curl	Late season vines
Little Marvel	ST/BP/FS/CH	Fusarium, mosaic	
Thomas Laxton	ST/BP/FM	Fusarium	
Wando	ST/BP/HF/FM	Fusarium, root rot	Tolerates heat

Edible Podded Peas

Variety	Source	Disease Tolerance	Other
Little Sweetie	ST/GA		Dwarf bush type, heat tolerant

Peanuts

Nuts are formed underground on pegs. Sow seeds in loose soil and harvest just prior to frost.

Variety	Source	Disease Tolerance	Other
Early Spanish	ST/FS/BU		

Peppers

These medium height, warm-season vegetables are started from plants. Peppers are sensitive to frost, and one should protect new plants from cutworms and flea beetles.

Variety	Source	Disease Tolerance	Other
Bell Boy Hybrid (AAS)	BP/PA/HF	Mosaic	Early, sweet, stuffing type
Cubanelle	HB/HM/GA		Sweet, yellow color, good for frying
Early Canada Bell	ST	Mosaic	
Early Niagara Giant	ST	Mosaic	
Keystone Resistant Giant	HA/HM/NK	Mosaic	Thick flesh, green
Long Red Cayenne	ST/BP/VJ	Bacterial spot	
Staddon's Select	HA		Early, bell type
Sunnybrook	BP/VJ/GA/GE	Bacterial spot	
Sweet Banana	ST/BP/HM/BA		
Yolo Wonder	ST/BP/HF/GE/NK	Mosaic	

Popcorn

Popcorn can be planted and cared for in the same way as sweet corn, and should mature in at least 100 days. Allow the ears to dry on the stalks. Sample the kernels occasionally while the crop dries. When the corn is dry enough to pop, harvest, shell and store in covered glass jars.

Variety	Source	Disease Tolerance	Other
Exp 63457	(see last page for sources)		Earliest of large kerneled types
Io Pop 12			Early, yellow, small kernel
Purdue 216A			Early, yellow, small kernel
Purdue 305			White, large kernel
Purdue 402			Early, large kernel
Purdue 410			Early, large kernel
Purdue 606			Late, small kernel (good for southern gardens)

Potatoes

Of medium height, potatoes are grown from pieces of other potatoes (seed sets). They need a long growing season, lots of space, and are killed by frosts. Buy only those seed sets certified to avoid disease. Spray or dust to control insects and leaf diseases. Store the harvested crop in cool, moist conditions.

Variety	Source	Disease Tolerance	Other
Kennebec	(Seed potatoes available at most farm and garden stores)	Late blight	White, late season
Norland*		Scab	Red, early season
Ontario		Scab, verticillium, late blight	White, early season
Superior		Scab	

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*Susceptible to air pollution injury such as ozone and sulfur dioxide.

Pumpkins

Not recommended for small gardens as these plants require lots of space and a long growing season. They grow best when the weather is warm and are frost-tender. Dust or spray to control cucumber beetles, which carry plant wilt disease. Store pumpkins for winter use when it is dry and fairly warm.

Variety	Source	Disease Tolerance	Other
Howden's Field	HA		Large sized
Jack O'Lantern	HB/HF/CH/NK/FM		Medium sized
Spirit (AAS)	ST/BP/BA/GA/GE		Medium sized

Radishes

Easy to grow. Radishes are excellent for children's gardens. Small plants, needing very little space, radishes are ready to eat in about 30 days. Thus, one may grow both a spring crop and a fall crop. Radishes grow best in cool weather and can take quite a bit of frost.

Variety	Source	Disease Tolerance	Other
Cherry Belle (AAS)	ST/BP/FS/HM/GA		
Comet (AAS)	ST/BP/FM		
Icicle	ST/BP/HF/GA/BU		White fleshed with long root
Red Prince Improved	ST	Fusarium	

Rutabaga

Variety	Source	Disease Tolerance	Other
Ultrasweet	ST		

Spinach

Fine for quick freezing or canning, this low-growing, high-yielding, and fast-growing plant needs little space and is frost-hardy, while growing fairly well in part shade.

Variety	Source	Disease Tolerance	Other
America (AAS)	ST/BP/PA/CH		Dark green, savoyed leaves
Long Standing Bloomsdale	BP/FS/GA		
Melody (AAS)	BP/PA/CH/GE/BU	Downy mildew	Large, semi-savoyed leaves

Squash, Summer

Squash can be frozen. It is of medium height and requires a lot of space. A warm-season crop, it is killed by frost. Control beetles by spraying or dusting. Select bush types for small gardens.

Variety	Source	Disease Tolerance	Other
Aristocrat (AAS)	BP/HM/GA		Bush type, dark green cylindrical fruit
Scallopini (AAS)	ST/BP/BA/CH/GE		Bush type, harvest throughout season
St. Pat Scallop (AAS)	HE		Bush type

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Squash, Fall-Winter

Vines of these varieties require lots of space and a long growing season. Plant them only after danger of frost is past. Control cucumber beetles, which carry bacterial wilt disease. Store these squash for winter use where it is dry and fairly warm (10°F).

Variety	Source	Disease Tolerance	Other
Blue Hubbard	BP/CH	Bacterial wilt	Vining type, good in storage
Buttercup	ST/HF/GE/FM	Bacterial wilt	Orange flesh, good in storage
Gold Nugget (AAS)	ST/GE		Golden flesh
Kindred (AAS)	PA		Short vines, good in small spaces
Table King (AAS)	ST/BA/CH/NK		Acorn type with orange/yellow flesh
Table Queen	ST/GA/BU		Acorn type with orange/yellow flesh
Waltham Butternut (AAS)	BP/HF/FM		Larger than regular butternut

Strawberries

Plant strawberries in good garden soil as soon as the ground can be worked in early April. Apply fertilizer ahead of plowing or rototilling. For June-bearing kinds, pinch off all the blossoms and fruit the first year planted, then pick the fruit the second year. For everbearers, let the blooms and fruits develop the first year, but pinch off runners as they form.

Variety	Source	Disease Tolerance	Other
Earliglo	RY		Early
Sunrise	RY/BU		Early
Guardian	BP		Midseason
Redchief	BP		Midseason
Surecrop	BP/HF		Midseason
Marlate	BP		Late season
Sparkle	BP/FS/BU		Late season

Sweet Corn

Here we have another favorite vegetable of home gardeners. Good for freezing or canning, this tall-growing plant needs lots of space. Plant after the danger of frost is past. For proper pollination, plant sweet corn in a block of several rows, not in a single long row. Dust or spray mid- and late-season varieties to control corn ear-worm.

Variety	Source	Disease Tolerance	Other
Barbecue	ST/BP		Early
Bellringer	HA	Maize dwarf, mosaic, virus, bacterial wilt	Yellow and white kernels
Comanche	SDY	Bacterial wilt, common smut, southern leaf blight	Yellow kernels
Comet	SDY	Northern and southern leaf blights, bacteria wilt, smut	White kernels
Country Gentleman	BP/HF/FM	Bacterial wilt, smut, rust	
Early Xtra Sweet (AAS)	BP/CH		
Gold Cup	HA		Early
Goldwinner	HA		Mainseason crop
Golden Beauty (AAS)	ST/BP/BU	Bacterial wilt	Early
Golden Cross Bantam	ST		
Iochief (AAS)	BP/CH/HF/GA		
Seneca Chief	ST	Bacterial wilt	
Silver Queen	ST	Helminthosporium, bacterial wilt	
Stylepak	SDY/FM	Head smut	Yellow kernels
Sundance	HA	Maize dwarf mosaic virus	Early

Sweet Potatoes

These potatoes grow on vines of medium height. Plant them after all danger of frost has passed. Sweet potatoes require lots of space and a long growing season (120 days). Start them from plants and purchase from any reputable company to avoid disease. Store them for winter where they can be warm and dry.

Variety	Source	Disease Tolerance	Other
Allgold	PA/FS	Wilt, internal corking, black rot, soil rot	
Centennial	PA	Wilt, internal corking, soil rot	

Swiss Chard

Chard is grown for "greens."

Variety	Source	Disease Tolerance	Other
Burpees's Rhubarb Chard	ST/BP/CH	Red stalks with	green leaves

Tomatoes

Tomatoes are a basic home garden vegetable. Excellent for canning, they can be grown on poles or allowed to grow on the ground. Tomatoes are a long-season crop that will not tolerate frost. Start them from plants, and protect new transplants from cutworms. Dust or spray your tomatoes during the growing season for leaf diseases and fruit rots.

Variety	Source	Disease Tolerance	Other
Beefeater Hybrid-VFN	ST/HF		
Better Boy-VFN	ST/HM		Indeterminant
Burpee's VF	BP/BA/GE		
Burpee's Big Girl VF	BP/GA		
Caro-Rich	ST	Fusarium	Gold color, high in vitamins, low acidity
Floramerica (AAS)	ST/GA/GE	Multiple disease resistance	
Heinz 1350	BP/VJ/GA/FM	Verticillium, Fusarium	Canning
Heinz 1370	ST/VJ	Fusarium	Canning
Heinz 1439	PA		Canning
Jet Star	HA		Indeterminant
Jubilee (AAS)	BP/GA		Large, orange
Roma VF	BP/BA	Verticillium, Fusarium	Paste, canning
Spring Giant (AAS)	BP/BA	Verticillium, Fusarium	Determinant, canning
Spring Set Hybrid	ST/VJ/NK	Verticillium, Fusarium	Extra early, canning
Sunray	HB/BP/GA/BU	Fusarium	Golden color
Ultra Boy-VFN	ST	Verticillium, Fusarium	
Ultra Girl	ST	Verticillium, Fusarium, nematodes	Tolerant to cracking
Wonder Boy-VF	ST/HF/CH/NK		Large, meaty fruits

Turnips

Turnips are a low-growing, high yielding crop that withstands frost. Store them for the winter where it is cool and moist.

Variety	Source	Disease Tolerance	Other
Justright	BP/FS/BU		
Tokyo Cross (AAS)	ST/BP/FS/CH		
Purple Top White Globe	ST/BP/HF/GH		

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Watermelon

This slow-growing vine crop requires a great deal of space and will not tolerate frosts. The gardener must dust or spray his melons to control beetles and leaf diseases.

Variety	Source	Disease Tolerance	Other
Allsweet	ST	Fusarium, anthracnose	Large fruit. Requires long growing season
Charleston Gray	ST/BP/HF/FM	anthracnose	Large fruit. Requires long growing season
Crimson Sweet	ST/BP/CH/NK/BU	Fusarium, anthracnose	Large fruit. Requires long growing season
New Hampshire Midget (AAS)	BP		Small fruit, early. Many seeds.
Sweet Favorite (AAS)	ST/GA/GG		
Sweet Princess	PA	anthracnose	Large fruit. Requires long growing season.
Top Yield Hybrid	BP	anthracnose	
Yellow Baby (AAS)	ST/FS/HM/BU		Lemon yellow flesh. Can be grown on a fence in small gardens

*Key to Sources

BP	Burpee Seed Co., Clinton, Iowa 52732
HA	Joseph Harris Co., Inc., Moreton Farm, Rochester, N.Y. 14624
HB	Herbst Brothers Seedsmen, Inc., 1000 N. Main St., Brewster, N.Y. 10509
PA	George W. Park Seed Co., Inc., Greenwood, SC. 29647
RY	Rayner Bros., Inc., Salisbury, MD 21801
SDT	Seedway, Inc., Hall, N.Y. 14463
ST	Stokes Seeds, Inc., Box 548, Buffalo, N.Y. 14240
FS	Farmer Seed and Nursery Co., Faribault, MN 55021
HF	Henry Field Seed and Nursery Co, Shenandoah, Iowa 51601
HM	Henry F. Michell, King of Prussia, PA
VJ	Vaughn-Jacklin Seed Co., Downer's Grove, IL
BA	Geo. J. Ball, Inc., West Chicago, IL
CH	The Charles C. Hart Seed Co, 304 Main Street, Wethersfield, CT 06109
GA	Germania Seed Co., 5952 N. Milwaukee Ave., Chicago, IL 60646
GE	German Seeds, Smith Port, PA 16749
NK	Northrup-King & Co., Minneapolis, MN.
FM	Ferry-Morse Seed Co., 111 Ferry-Morse Way, P.O. Box 100, Mountain View, CA 94040
BU	Burgeson Seed & Plant Co., Galesburg, MI 49053

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Related Publications

Contact your county Extension office or Mailing Room, Agricultural Administration Building, Purdue University, West Lafayette, Indiana 47907.

HO-96	Asparagus
HO-62	Irish Potatoes
HO-66	Fall Vegetable Garden
HO-134	Peanuts
HO-5	Planning the Vegetable Garden
HO-6	Planting the Vegetable Garden
HO-7	Care of the Vegetable Garden
HO-26	Tomatoes
HO-46	Growing Strawberries
HO-98	Growing Sweet Corn
HO-32	Home Gardener's Guide
HO-29	Growing Salad Vegetables
HO-67	Onions and Their Relatives
HO-124	Small Plot Gardening
HO-136	Sweet Potatoes
BP-8-1	Tomato Disease Control in the Home Garden
BP-8-6	Vegetable Disease Control
E-21	Vegetable Insect Control in the Home Garden

SOURCES FOR SEEDS AND PLANTS

Seed companies

Agricultural Alumni Seed Improvement Association, Romney, Indiana 47981 (Minimum order sweet corn and popcorn is 1 lb.)

Burrell Seed Growers Co., Rocky Ford Seed House, Rocky Ford, Colorado 81067

Bunton's Seed Company, 939 E. Jefferson Street, Louisville, Kentucky 40206

Burgess Seed & Plant Co., Galesburg, Michigan 49053

W. Atlee Burpee Co., Clinton, Iowa 52732

Farmer Seed & Nursery Co., Faribault, Minnesota 55021

Ferry Morse Seed Co., Inc., P.O. Box 100, Mountainview, California 94042

Henry Field Seed and Nursery Co., Shenandoah, Iowa 51601.

German Seeds, Smith Port, Pennsylvania 16749

Gurney Seed and Nursery Co., Yankton, South Dakota 57078

Joseph Harris Co., Moreton Farm, Rochester, New York 14624

Holmes Seed Company, Canton, Ohio 44701

Keystone Seed and Plant Co., Galesburg, Michigan 49053

Kilgore Seed Co.—Asgrow, Plant City, Florida 33566

Henry F. Michell Co., King of Prussia, Pennsylvania 19406

The Charles C. Hart Seed. Co., 304 Main Street, Wethersfield, Connecticut 06109

Germania Seed Co., 5952 North Milwaukee Ave., Chicago, Illinois 60646

Herbst Brothers Seedmen, Inc., 1000 N. Main Street, Brewster, New York 10509

Letherman Seed Company, Canton, Ohio 44701

Earl May Seed and Nursery Co., Shenandoah, Iowa 51601

Ken Meyer Seed Co., Inc., 120 Willow Street, Vincennes, Indiana

Northrup King and Co., Minneapolis, Minnesota 55413

Geo. W. Park Seed Co., Inc., Greenwood, South Carolina 29646

Seedway Inc., Hall, New York 14463

Roger's Seeds, P. O. Box 2188, Idaho Falls, Idaho 83401

Stokes Seeds, Inc., Box 15, Ellicott Street Station, Buffalo, New York 14205

Otis S. Twilley, Salisbury, Maryland 21801

R. H. Shumway, Rockford, Illinois 61101

Plant companies

Have transplants of cabbage, onion, peppers, strawberries, sweet potatoes, tomatoes, and white potato seed "sets."

Ahrens Strawberry Nursery, R. R. 1, Huntingburg, Indiana 47542 (strawberry plants only)

Cupp Plant Farms, R. R. 1, Cullman, Alabama 35055 (sweet potatoes and strawberries only)

P.D. Fulwood Co., Tifton, Georgia 31794

Piedmont Plant Co., Drawer A, Albany, Georgia 31702

Steel Plant Company, Gleason, Tennessee 38229

You may also obtain seed packets from the following wholesale companies on garden counters only:

Geo. J. Ball, Inc., West Chicago, Illinois

Fred C. Gloeckner & Co., Inc. New York, New York

Henry F. Michell Co., King of Prussia, Pennsylvania

Goldsmith, Gilroy, California

Northrup King & Co., Minneapolis, Minnesota

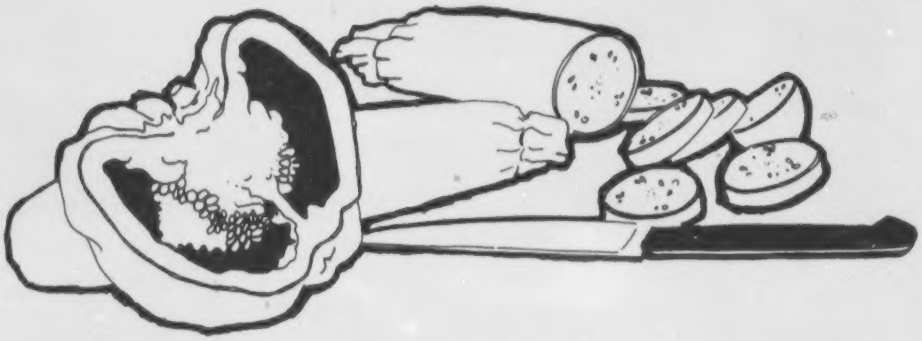
Pan-American Seed, West Chicago, Illinois

Vaughn-Jacklin Seed Co., Downer's Grove, Illinois

Asgrow Seed Co., Kalamazoo, Michigan 49001

Ferry-Morse Seed Co., 111 Ferry-Morse Way, P.O. Box 100, Mountain View, California 94040

The information given herein is provided with the understanding that no discrimination is intended and no endorsement by the Indiana Cooperative Extension Service is implied.



Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U.S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

LESSON 7: VEGETABLE AND FRUIT PRODUCTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. Write a description of fruit and vegetable production trends as based on census information.
2. List the requirements for success in the vegetable and fruit business.
3. Identify vegetables and fruits in Indiana from samples and pictures.

MOTIVATION:

Ask the students which vegetables and fruit crops occupy the greatest land area in Indiana and in the country. Which vegetable and fruit crops have the greatest monetary value in Indiana and in the country?

REFERENCES:

Raising Vegetables, The Interstate Printers

Identifying Horticultural Crops Manual, Purdue University, HO-55

1974 Census of Agriculture, Indiana, Bureau of the Census

1974 Census of Agriculture, Preliminary Report, Indiana, Bureau of the Census

1974 Census of Agriculture, Preliminary Report (your county), Bureau of the Census

Fruit and Vegetable Catalogs

Handout: "Recommended Vegetable Varieties," Purdue University, HO-101

Transparency Master: "Limiting Factors and Requirements for Success"

OUTLINE:

A. Scope and Importance of Vegetable and Fruit Production in Indiana:
   1. Vegetables, sweet corn, or melons for sale:
      a. 1969 - 50,857 acres
      b. 1974 - 46,257 acres

2. Apples for sale:

   a. 1969 - 66,830,084 lbs.
   b. 1974 - 56,961,794 lbs.

B. Scope and Importance of Vegetable and Fruit Production in Local Area:

   1. Vegetables

   2. Fruit

C. Limiting Factors and Requirements for Success:

   1. Climate. Must be suited to the crop.

   2. Soil requirements. Should be best suited to the crop.

   3. Labor requirements. Seasonal labor is a necessity.

   4. Transportation. Transportation to market should be available and economical.

   5. Long-range investment in orchards. Years.

   6. Short-range investment in vegetables. Yearly.

   7. Cooperative marketing organization. Used by both.

   8. The grower. Educated and experienced is best.

D. Identify Common Fruits and Vegetables in Local Area:

TEACHING LEARNING ACTIVITIES:

1. Have the class help to decide how to tabulate the data on acreage, value, and yield on fruits and vegetables in Indiana and in your area from the census reports.

2. Summarize to help students to remember the important fruit and vegetable crops and why some are increasing in Indiana and local areas while others are declining.

3. Discuss limiting factors and requirements of fruit and vegetable production with the class. Note and provide ideas on how the limiting factors can be used to the advantage of the producer.

4. Discuss fruit and vegetable information from Identifying Horticultural Crops Manual.

5. Conduct a field trip to a fruit and vegetable producer's or seller's location.

SUGGESTED EVALUATION

1. Evaluate student data sheets on fruit and vegetable production.
2. Give a written test to evaluate students' knowledge of fruit and vegetable production in Indiana and in the local area.
3. Construct a matching test and have students match names of fruits and vegetables with the fruit or vegetable or match using visual aids.

LIMITING FACTORS AND REQUIREMENTS FOR SUCCESS

CLIMATE

SOIL

TRANSPORTATION

LABOR REQUIREMENTS

LONG-RANGE INVESTMENT

SHORT-RANGE INVESTMENTS

COOPERATIVE MARKETING

THE GROWER

UNIT VIII

CONSERVATION OF NATURAL RESOURCES
Introduction to the Unit

In this unit, the student will be introduced to the basic concepts of conservation of natural resources. The importance and preservation of our natural resources is stressed. Emphasis will also be given to ways students can apply conservation principles to their home environment, whether they live in city, rural or urban areas.

LESSONS:

1. Importance of Conservation of Natural Resources
2. Environment and Ecology
3. Plant Successions
4. Recreation and Scenery
5. Food Webs
6. Water
7. Water Pollution
8. History and Importance of Forests
9. Forestry Identification
10. Forest Management and Associated Problems
11. History and Importance of Wildlife
12. Wildlife Classification
13. Wildlife Management
14. Fisheries and Fish Management

OBJECTIVES:

Upon the completion of this unit, the student will be able to:

1. Define conservation of natural resources.
2. Write a paragraph discussing the importance of conservation of natural resources.

3. List methods and ways to conserve our natural resources.
4. List ways to prevent wasteful practices of our natural resources.
5. Develop a plan for the conservation of natural resources at each individual home.
6. Directly relate conservation of natural resources to man's future and survival.

MOTIVATION:

It is imperative that conservation of natural resources become more important and more people become aware of it, if man is to survive. Ask the students to describe a world without conservation. What problems would there be today without conservation? Discuss the significance of these two questions. What resources is man wasting? How can the wasteful practices of these resources be prevented? Does the statement, "Waste not, want not" hold true today?

TEACHING REFERENCES:

A. General Information:

1. Patterns for Preservation, A Conservation Text.
2. Workbook for Patterns for Preservation, A Conservation Text.
3. Outdoor Indiana, July-August 1977.
4. Outdoor Recreation in America, Burgess Publishing Company.
5. How to Know the Mammals, Wm. C. Brown Co.
6. Birds of North America, Western Publishing Co.
7. National Wildlife, December-January 1978.

B. Addresses for Reference Materials:

1. National Farm Book Company
Ray Hoeft, Manager
458 Waukau Road
P O Box 458
Omro, Wisconsin 54963

2. National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

14. Hoosier Conservation
P. O. Box 672
Muncie, Indiana 47305

C. Transparency Masters:

1. "Lost Farm Land"
2. "Nature's Pantry"
3. "Plant Successions"
4. "Game Pyramid"
5. "Fish Food Chain"
6. "Fish Food Chain"
7. "Wildlife Food Web"
8. "Recreational Activities"
9. "Litter in our Public Parks"
10. "Here Come the Nature Lovers"
11. "The Hydrologic Cycle"
12. "Water Demand vs. Supply"
13. "Water Users"
14. "Water Requirement Tables of Selected Farm Products"
15. "Partial List of Products From Trees"
16. "Livestock in Woods"
17. "Injun Summer"
18. "Leaf Terms and Forms"
19. "Why You Lose Money When You Graze Your Woodlands"
20. "Recommended Care for Your Woodlands"
21. "Economic Values of Wildlife"
22. "Some Endangered and Exterminated Species of Wildlife"
23. "Some Game Birds Found in Indiana"

3. Burgess Publishing Company
426 South Sixth Street
Minneapolis, Minnesota 55415

4. Wm. C. Brown Company
2460 Kerper Boulevard
Dubuque, Iowa 52001

5. Western Publishing Company
850 3rd Avenue
New York, New York 10022

6. Outdoor Indiana
Room 612
State Office Building
Indianapolis, Indiana 46204

7. Cooperative Extension Service
Mailing Room
Agricultural Administration Building
Purdue University
West Lafayette, Indiana 47907

8. Purdue A.V. Center
Stewart Center
Purdue University
West Lafayette, Indiana 47907

9. Indiana Department of Natural Resources
Division of Fish and Wildlife
607 State Office Building
Indianapolis, Indiana 46204

10. Indiana Department of Natural Resources
Enforcement Division
606 State Office Building
Indianapolis, Indiana 46204

11. Indiana Department of Natural Resources
Division of State Parks
616 State Office Building
Indianapolis, Indiana 46204

12. Indiana Department of Natural Resources
Division of Outdoor Recreation
State Office Building
Indianapolis, Indiana 46204

13. Indiana Department of Natural Resources
Division of Forestry
State Office Building
Indianapolis, Indiana 46204

24. "Some Unprotected Birds Found in Indiana"
25. "Some Game Animals Found in Indiana"
26. "Some Non-Game Animals Found in Indiana"
27. "Some Fur-Bearing Animals Found in Indiana"
28. "Some Protected Birds Found in Indiana"
29. "Scientific Classification of Wolf vs. Fox"
30. "Natural Wildlife Problems"
31. "Trends in Angling Participation"
32. "The Effects of Fishing on Fresh Water Populations"

D. Films:

1. Conserving Our Natural Resources
2. The Cottontail
3. Watershed
4. Water
5. Water For Farm and City
6. It's Your Decision - Clean Water
7. The Forest
8. Wilderness Trail
9. Wildlife and Timber
10. Man Against Fire
11. Conserving Our Wildlife Today
12. Bobwhite Through the Year
13. Headwaters

E. Handouts:

1. "Conservation Problems Here?", I.D. 92, Cooperative Extension Service, Purdue University
2. "Indiana's 120 State Access Sites and Our 15 State Fishing Areas"
3. "Forests of Indiana", F-34 Cooperative Extension Service, Purdue University
4. "Some Important Indiana Woods, Their Properties and Uses", F-27 Cooperative Extension Service, Purdue University
5. "Forestry and Wildlife as a Career", F-53 Cooperative Extension Service, Purdue University
6. "Forests and Our Environment", F-63 Cooperative Extension Service, Purdue University
7. "A Key to the Summer Identification of Some deciduous Trees and Shrubs in Indiana", F-22 Cooperative Extension Service, Purdue University
8. "A Key to the Evergreens of Indiana", F-12 Cooperative Extension Service, Purdue University
9. "How to Identify Some Common Indiana Woods", F-43 Cooperative Extension Service, Purdue University
10. "Common Tree and Shrub Pests", Picture Sheet No. 3, Cooperative Extension Service, Purdue University
11. "Timber Theft", F-68 Cooperative Extension Service, Purdue University
12. "Management of Farm Woods", F-18 Cooperative Extension Service, Purdue University
13. "How to Plant Hardwood Seedlings", F-54 Cooperative Extension Service, Purdue University
14. "Managing Woodland for Wildlife", Management Series No. 3, Indiana Department of Natural Resources
15. "Five Pointers on Farm Woodlands", F-47 Cooperative Extension Service, Purdue University
16. "A Brief History of Wildlife in Indiana", Indiana Department of Natural Resources, Division of Fish and Wildlife
17. "Let's Help the Wood Duck", Circular No. 3, Indiana Department of Conservation, Division of Fish and Game, 6055 State Office Building, Indianapolis, Indiana

18. "Artificial Homes for Wildlife", Management Series No. 2, Indiana Department of Natural Resources

19. "Managing Idle Lands for Wildlife", Management Series No. 3, Indiana Department of Natural Resources

20. "Wildlife Management With Herbaceous Cover", Management Series No. 4, Indiana Department of Natural Resources

21. "Wildlife Management with Trees and Shrubs", Management Series No. 9, Indiana Department of Natural Resources

22. "Birds in Your Back Yard", Indiana Department of Natural Resources

23. "Controlling Nuisance Non-Game Wildlife", Management Series No. 9, Indiana Department of Natural Resources

24. "Common Wildlife Diseases and Parasites", Management Series No. 11, Indiana Department of Natural Resources

25. "ABC's of Hunting"

26. "Indiana Warm Water Fish Management", Indiana Department of Natural Resources, Division of Fish and Wildlife

27. "Lake Surveys - A Valuable Source of Fishing Data", Indiana Department of Natural Resources, Division of Fish and Wildlife

28. "Lake Restoration with Chemicals", Indiana Department of Natural Resources, Division of Fish and Wildlife

29. "Fish Stocking - Indiana Style", Indiana Department of Fish and Wildlife

30. "What You Ought to Know About Fish Management", Indiana Department of Natural Resources, Division of Fish and Wildlife Copyright Outdoor Indiana, 1977

31. "What Causes Fish Kills in Indiana", Indiana Department of Natural Resources, Division of Fish and Wildlife

32. "Fish Kills in Indiana---Their Causes and Prevention", FNR-69, April 1977, Cooperative Extension Service, Purdue University

33. "Your Fishing License Money at Work", Indiana Department of Natural Resources, Division of Fish and Wildlife

34. "What's Happening to our Stream Fisheries?" Indiana Department of Natural Resources, Divison of Fish and Wildlife

F. Selected List of Audiovisual Aids

Included here is an additional list of selected audiovisual aids for an instructor who wishes to spend more time in one of the specific areas of conservation of National Resources, or who wishes to teach a semester course in conservation. This list was compiled by the Department of Agriculture Education, Pennsylvania State University, University Park, Pennsylvania, 1973.

The following audiovisual materials are suggested to supplement the natural resource units of instruction. They are organized by natural resource instructional area; however, some audiovisual aids may be applicable to several areas.

Because there is considerable interest across the nation in natural resources and environmental education, the demand for these materials is enormous. When borrowing films, always give a second and third choice of show dates. Some materials may go out of print; others are being revised; some new ones are being developed. For these reasons, it is suggested that teachers, when writing to a given source, ask for a current list of resource materials.

AIR

"Air Pollution and You." Outlines basic problem of air pollution, its principal effects on health and property, some approaches to its control, and the federal program. Filmstrip, color, 46 frames, sale. Current Affairs Films, 527 Madison Avenue, NY 10022.

"Air Pollution: Take a Deep Deadly Breath." An examination of the air pollution problem, a survey of the measures that have been taken to solve the problem, and why they have failed. Film, 16mm, color, 54 minutes, sale $610, rental $40. Contemporary Films/McGraw Hill, 327 West 41st Street, New York, NY 10036.

"Answer is Clear, The." Discusses aspects of air pollution and progress made in reducing diesel exhaust smoke and odor. Film, 16mm, color, 14 minutes, free loan. Modern Talking Picture Service, Inc., 2323 New Hyde Park, New Hyde Park, NY 11040.

"First Mile Up, The." The Detroit River region and Toronto are studied to show the urgency of the problem of air pollution, and how some North American cities are fighting it. Film, 16mm, black and white, 28 minutes, sale $200, rental $14. Contemporary Films/McGraw Hill, 327 West 41st Street, New York, NY 10036.

"Poisoned Air, The." Spans the world with scenes of air pollution. City programs are shown, and the importance of citizen action is emphasized. Film, 16mm, color, 50 minutes, rental $10.50. Audio-Visual Services, 7 Willard Building, University Park, PA 16802.

FISH

"Brook Trout – Facts and Figures." Record of field research project designed to provide scientific knowledge needed to preserve brook trout population. Film, 16mm, color, 45 minutes, rental $15.70. Audio-Visual Services, 7 Willard Building, University Park, PA 16802.

"Perch Anatomy." Shows exterior structure, coloration, dissection technique, and internal structures. Film, 16mm, color, 16 minutes, rental $6.10. Audio-Visual Services, 7 Willard Building, University Park, PA 16802.

"Reservoir Fisheries of the Future." Points out the various conditions of a reservoir that must be kept at maximum natural levels including oxygen, food, light, shelter, and temperature. Film, color, 16mm. Audio-Visual Services, 7 Willard Building, University Park, PA 16802.

"Trout Hatchery." Shows stripping of eggs and sperm from adult fish by hatchery workers, resulting embryos, and emergence of young fish from eggs. Film, 16mm, color, 15 minutes, rental $6.60. Audio-Visual Services, 7 Willard Building, University Park, PA 16802.

"Trout, U.S.A." View the life of a trout both in its natural habitat and on a trout farm. Film, 16mm, color, 10 minutes, service charge, $5.***

FORESTRY

"Building the Fireline." Typical forest fire problems and tactics used to control them. Film, 16mm, color, 26 1/2 minutes, free loan. John Hall Film Service, 1923 West Atkinson Street, Milwaukee, WI 53212.

"Chain Saw Safety Pays Off." Procedures for using the chain saw. Film, 16mm, color, 27 minutes, free loan. American Pulpwood Association, 605 Third Avenue, New York, NY 10016.

"Direct Seeding of Southern Pine." This film deals with research leading to the successful direct seeding of southern timberlands. Film, 16mm, color, 20 minutes, service charge.*

"Eternal Forest, The." Presents the popular subject of man and his environment – specifically forests and woodlands. Film, color, 16mm, 21 minutes, service charge.*

"Family Forest, The." A documentary of the ceremonies honoring the first privately owned woodland in the nation to be officially designated a "Family Forest." Film, 16mm, color, 12 1/4 minutes, service charge.*

"Fire Control Simulator." Explains the use of the simulator and the various advantages of its many uses. Film, 16mm, color, 11 1/2 minutes, service charge.*

"Fire vs Fire." Instructs fire-control managers in developing abilities to know when and why fire should be used in fire control and the technical requirements of using fire in this way. Film, 16mm, color, 26 minutes, service charge.*

"Forest, The." No. C-89. A visual description of the many benefits derived from our forests through "multiple-use" management of our forest resources. 47 frames, filmstrip, $5.50**

"Forest, The." Multiple use benefits of forests. Film, 16mm, color, 28 minutes, free loan. John Hall Film Service, 1923 West Atkinson Street, Milwaukee, WI 53212.

"Introduction to Fire Behavior." This is a training film for firefighters and initial attack foreman. Film, 16mm, color, 17 minutes, service charge.*

"Rainbow Valley." Story of a forest ranger. Film, 16mm, color, 29 minutes, free loan. John Hall Film Service, 1923 Atkinson Street, Milwaukee, WI 53212.

"Tree Farm, The." Modern day methods of harvesting. Film, 16mm, color, 13½ minutes, free loan. American Forest Institute, 1835 K Street, N.W., Washington, DC 20006.

"Tree is Born, A." History and legend of Christmas trees. Film, 16mm, color, 11 minutes, free loan. John Hall Film Service, 1923 West Atkinson Street, Milwaukee, WI 53212.

"Working Forest, A." Explains the reasons for and methods of establishing a local forestry cooperative. Film, 16mm, color, 18 minutes, service charge.*

LAND USE PLANNING

"Bulldozed America." Shows some of the most serious threats to natural beauty and wilderness. Film, 16mm, black and white, 27 minutes, rental $10. National Audubon Society, 1130 5th Avenue, New York, NY 10028.

"Cities of the Future." Focuses on creative urban planning now in progress. Film, 16mm, color, 25 minutes, sale $325, rental $18. Contemporary Films/McGraw Hill, 327 West 41st Street, New York, NY 10036.

"Green City, The." Exposes the devastating destruction that occurs when trees and landscapes are irresponsibly leveled . . . and what can be done about it. Film, 16mm, color, 23 minutes, service charge, $5.***

"Multiply and Subdue The Earth." Depicts people and their utter disregard for nature through lack of awareness and indiscriminate use of the soil, water, and land. Film, 16mm, color, 2 reels, 33 1/2 minutes each, service charge, $5 per reel.***

"Urban Sprawl vs Planned Growth." Illustrates the awkward, haphazard and graceless urban development which has taken place and offers some plans for improvement. Film, 16mm, color, 21 1/2 minutes, service charge, $5.***

MINERALS AND MINERAL FUELS

"Barrel Number One." Shows the various steps involved in the discovery, production, refining, transportation, and marketing of a barrel of oil. Film, 16mm, black and white, 29 minutes, free loan. American Petroleum Institute, 1801 K Street, N.W., Washington, DC 20006.

"Coal and Water." Shows how mining practices, both surface and underground, may be modified to minimize acid drainage. Film, 16mm, color, 23 minutes, sale $200. Stuart Finley, 6926 Mansfield Road, Falls Church, VA 22041.

"Grain of Salt, A." Shows modern processing methods preparing salt for a variety of uses in the home, on farms, and in industry. Film, 16mm, color, 28 minutes, free loan. Modern Talking Picture Service, 2323 New Hyde Park Road, New Hyde Park, NY 11040.

"Greatest Good, The." Shows need for cooperation between mining and conservation. Film, 16mm, color, 28 minutes, free loan. Colorado Mining Association, 402 Majestic Building, 290 South 16th Street, Denver, CO 80202.

"Minerals." Wise use of non-renewable natural resources. Film, 16mm, color, sale $200. Encyclopaedia Britannica Educational Corporation, 425 North Michigan Avenue, Chicago, IL 60611.

"Ravaged Earth, The." Acidic soil, sulphuric rivers, and unhappy people mark the path of strip mining across Appalachia. Film, 16mm, color, 27 minutes, sale $330, rental $15. NBC Educational Enterprises, Inc., 30 Rockefeller Plaza, New York, NY 10020.

"Wide World of Petroleum." A film about people doing the hundreds of jobs required to produce petroleum energy. Film, 16mm, color, 18 minutes, free loan. American Petroleum Institute, 1801 K Street, N.W., Washington, DC 20006.

RANGE

"Grass, The Big Story." Shows how grass improves the soil and prevents erosion and floods, and many other benign effects of these grasslands. Film, 16mm, color, 29 minutes, service charge, $5.***

"Ranchers and Rangers." Story of grass and beef production through cooperative efforts of the Colorado Cattlemen's Association and public range managers. Film, 16mm, color, 18 3/4 minutes, service charge.*

"Range Allotment Analysis." Describes the systematic method used by range managers in the Forest Service to collect information on which to base their management plans and decisions for the National Forests and National Grasslands. Film, 16mm, color, 46 1/2 minutes, service charge.*

"Rangeland Research at Manitou." Shows the various experiments being conducted at the Manitou Experimental Forest, featuring the effects on land and water of different degrees of grazing – moderate, light, and heavy. Film, 16mm, color, 20 1/2 minutes, service charge.*

"Teamwork on the Nevada Range." Story of rural development through the combined efforts of Government agencies and Nevada ranchers. Film, 16mm, color, 18 minutes, service charge.*

RECREATION

"Community Lake." Working hand-in-hand with the conservation commission, a local community is shown in the construction, maintenance, and enjoyment of the many recreational facets of the lake. Film, 16mm, color, 27 minutes, service charge, $5.***

"New Opportunities in Rural Recreation." No. C-125. Describes various types of recreational projects that are being developed. 50 frames, color, mounted slides $8, filmstrip $5.50. Photography Division, Office of Information, U.S. Department of Agriculture, Washington, DC 20250.

"Rural Holidays." Rural recreation for city folks a new source of income for farmers. Film, 16mm, color, 25 minutes, service charge, $5.***

"Tent Flaps and Flapjacks." Deals with recreational opportunities in the National Forests in the North-Central states. Film, 16mm, color, 25 1/2 minutes, service charge.*

SOIL

"Beyond Tomorrow." Portrays a total coordination of the soil conservation districts and local farmers concerning the development and management of our natural resources for future use. Film, 16mm, color, 23 minutes, service charge, $5.***

"Dust is Dying, The." Shows how farmers and ranchers of the Great Plains are preparing to prevent disaster when the next, inevitable drought comes. Film, 16mm, color or black and white, 13 1/2 minutes, service charge.*

"Know Your Land." Outlines and analyzes the eight basic classes of land. Film, 16mm, color, 10 minutes, service charge, $3.***

"Know Your Land." No. C-8. This presentation shows a practical land classification method that will indicate the best land use and treatment for the various areas of a farm. 50 frames, color mounted slides $8, filmstrip $5.50.**

"Mud." Discusses how to control erosion and sedimentation during the urbanizing process. Film, 16mm, color, 20 minutes, service charge, $5.***

"New Life For The Great Plains." Promotes the Great Plains Soil Conservation Program by showing the progress made in soil and water conservation. Film, 16mm, color, 12 minutes, service charge.*

"Raindrops and Soil Erosion." The real power of raindrops is portrayed in this film. Film, 16mm, color, 21 minutes, service charge, $5.***

"Soil Conservation District, The." Explains what a district is and how it functions. Film, 16mm, color, 14 1/2 minutes, free loan. Venard Films, Box 1332, Peoria, IL 61601.

"To Save Our Land." No. C-141. Covers the work of the U.S. Soil Conservation Service from its establishment up through modern times. 48 frames, color mounted slides $8, filmstrip $5.50.**

"Washout." No. C-160. Examines the problem of urban erosion and resulting pollution of the streams and rivers and suggests some methods of controlling it. 50 frames, color mounted slides $8, filmstrip $5.50.**

"Water Everywhere Farm Ponds." The story of how and why farmers and city people can benefit from good management of the water that falls on farmland. Film, 16mm, color, 6 minutes, service charge.*

"Water Movement In The Soil." A series of laboratory experiments, and through the use of time-lapse photography it examines the principles governing water flows. Film, 16mm, color, 25 minutes, service charge, $5.***

WATER

"How To Make a Dirty River." Take a clean river, add sewage, chemicals, heat, detergent, and people who don't care – now, how is it made clean again? Film, 16mm, color, 27 minutes, sale $330, rental $15. NBC Educational Enterprises, Inc., 30 Rockefeller Plaza, New York, NY 10020.

"Irrigating The Electric Way," No. C-38. Covers the many benefits of flood and sprinkler type irrigation and the advantages of driving the pumps by electricity. 65 frames, color mounted slides $10.50, filmstrip $7.50.**

"It's Your Decision: Clean Water." Animated figures show the basic characteristics of polluted water and how water treatment plants operate. Film, 16mm, color, 14 minutes, free loan. Associate Films, Inc., Regional Film Centers, 600 Grand Avenue, Ridgefield, NJ 07657; 561 Hillgrave Avenue, LaGrand, IL 60525; 324 Delaware Avenue, Oakmont, PA 15139.

"River Must Live, The." Introduction to water pollution and wastewater treatment. Film, 16mm, color, 21 minutes, free loan. Shell Film Library, 450 North Meridian Street, Indianapolis, IN 46204.

"This Land is Ours." Shows how land-water resources are rebuilt and strengthened as individuals and communities utilize financial and technical help through the Agricultural Conservation Program. Film, 16mm, color, 28 1/4 minutes, service charge.*

"Water." Explores the esthetic and practical use of water and encourages wiser use and reuse. Film, 16mm, color, 27 minutes, free loan. Modern Talking Picture Service, Inc., 2323 New Hyde Park Road, New Hyde Park, NY 11040.

"Water Resourcefulness." New York State's coordinated water resources program. Film, 16mm, color, 20 minutes, sale $200, rental $15. Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, VA 22041.

"Waters From The Mountain." Shows us how the snow surveyor measures water content in the snow and determines what we can expect when the snow melts. Film, 16mm, color, 20 minutes, service charge.*

"Watershed Projects For Protection and Profit." No. C-128. Describes how proper conservation practices can greatly limit the ravages of uncontrolled water and at the same time make additional water supplies available. 55 frames, color mounted slides $9, filmstrip $6.50.***

WILDLIFE

"Big Game Management on Public Lands." No. C-159. Explains where different species of wild animals are found and how most big game animals, especially deer, are making a steady increase in population through the work of conservation organizations, 79 frames, color mounted slides $12.50, filmstrip $8.50.**

"Birds of Prey." No. C-178. Discusses the role of some birds of prey in nature and describes identifying characteristics for several species. 51 frames, color mounted slides $12, filmstrip $6.50.**

"Making Plaster Casts of Animal Tracks." No. C-174. This step-by-step presentation shows what materials are needed and how they should be used to make good plaster casts of animal tracks. 29 frames, color mounted slides $11, filmstrip $5.50.**

"Patterns of The Wild." Through the eyes of a wild fox, you see that the wildlife of a forest does not merely inhabit a forest, but is a part of its structure. Film, 16mm, color, 26 minutes, service charge.*

"Sharing Our Land With Wildlife." No. C-177. Shows how soil and water conservation measures benefit wildlife on 60 percent of the land area in the United States. 58 frames, color mounted slides $12, filmstrip $6.50.**

"Some Game Birds of North America." No. C-172. Describes many of the most popular game birds in this country and gives information to help hunters and farmers attract them to hunting areas. 48 frames, color mounted slides $11, filmstrip $5.50.**

"We Share This Land." This is the story of how conservation practices bring beneficial wildlife back to the farm. Film, 16mm, color, 14 1/4 minutes, service charge.*

"Wildlife For All." No. C-175. This conservation story tells some of the benefits of having wildlife live among us. 40 frames, color mounted slides $11.50, filmstrip $5.50.**

MISCELLANEOUS

"Agricultural Science Protects Our Environment." No. C-140. Describes new ways of coping with problems developing out of increased population and industrialization. 49 frames, color mounted slides $8, filmstrip $5.50.**

"Careers in Natural Resource Management." Describes typical jobs in fish, wildlife and outdoor recreation. 53 frames, color mounted slides, sale $7.95. Vocational Education Productions, California State Polytechnic College, San Luis Obispo, CA 93401.

"Ecology and Agriculture." Multi-media kit including five full color filmstrips; illustrated filmstrip scripts; narration or recorded reel tape, or cassette; overhead transparency masters; resource manual for teacher or student; and supplemental booklets from leading conservation organizations. Vocational Education Productions, California State Polytechnic College, San Luis Obispo, CA 93401.

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*U.S. Department of Agriculture film available from state film libraries. Write Motion Picture Service, Office of Information, U.S. Department of Agriculture, Washington, DC 20250 for locations of these lending libraries.

**Available from Photography Division, Office of Information, U.S. Department of Agriculture, Washington, DC 20250.

***National Association of Conservation Districts, Environmental Film Service, P.O. Box 855, League City, TX 77573.

G. Selected List of Professional and Technical Societies and Organizations concerned with Natural Resources.

Included here is a list of selected professional and technical societies and organizations concerned with Natural Resources. Anyone wishing further information about conservation of natural resources may write to these addresses requesting the information. There are enough addresses to make this a classroom project.

SELECTED LIST OF PROFESSIONAL AND TECHNICAL SOCIETIES AND ORGANIZATIONS CONCERNED WITH THE NATURAL RESOURCES

The following natural resources and conservation societies and organizations are a source of occupational information and reference data. If you would like information from any of these organizations, address your letter to the executive secretary at the address shown.

AIR POLLUTION CONTROL ASSOCIATION, 440 Fifth Avenue, Pittsburgh, PA 15213
AMERICAN CONGRESS ON SURVEYING AND MAPPING, 733 15th Street, N.W., Washington, DC 20005
AMERICAN FISHERIES SOCIETY, 1040 Washington Building, 15th and New York Avenues, N.W., Washington DC 20005
AMERICAN FOREST INSTITUTE, 1835 K Street, N.W., Washington, DC 20006
AMERICAN FOREST PRODUCTS INDUSTRIES, 1816 N Street, N.W., Washington, DC 20006
THE AMERICAN FORESTRY ASSOCIATION, 1319 18th Street, N.W., Washington, DC 20036
AMERICAN GEOLOGICAL INSTITUTE, 2201 M Street, N.W., Washington, DC 20037
MERICAN GEOPHYSICAL UNION, 2100 Pennsylvania Avenue, N.W., Washington, DC 20037
AMERICAN INSTITUTE OF PLANNERS, 917 15th Street, N.W., Washington, DC 20005
AMERICAN METEOROLOGICAL SOCIETY, 45 Beacon Street, Boston, MA 02108
AMERICAN PETROLEUM INSTITUTE, 1271 Avenue of the Americas, New York, NY 10020
AMERICAN PULPWOOD ASSOCIATION, 605 Third Avenue, New York, NY 10016
AMERICAN SOCIETY OF PHOTOGRAMMETRY, 644 Leesburg Pike, Falls Church, VA 22044
AMERICAN WATER RESOURCES ASSOCIATION, P.O. Box 434, Urbana, IL 61801
AMERICAN WATER WORKS ASSOCIATION, 2 Park Avenue, New York, NY 10016
ASSOCIATION OF INTERPRETIVE NATURALISTS, 1251 E. Broad Street, Columbus, OH 43205
CONSERVATION EDUCATION ASSOCIATION, Box 450, Madison, WI 53701
ECOLOGICAL SOCIETY OF AMERICA, Oak Ridge National Laboratory, Radiation Ecology Division, Oak Ridge, TN 37831
ENTOMOLOGICAL SOCIETY OF AMERICA, 5603 Calvert Road, College Park, MD 20740
INCINERATOR INSTITUTE OF AMERICA, 60 East 42nd Street, Suite 1914, New York NY 10017
INSTITUTE OF ENVIRONMENTAL SCIENCES, 34 South Main Street, Mt. Prospect, IL 60057
NATIONAL ASSOCIATION OF SANITARIANS, University of Denver, Denver, CO 80203
NATIONAL COAL ASSOCIATION, Coal Building, 1130 Seventeenth Street, N.W., Washington, DC 20036
NATIONAL PARKS AND CONSERVATION ASSOCIATION, 1701 18th Streeet, N.W., Washington, DC 20009
NATIONAL RECREATION, AND PARK ASSOCIATION, 1700 Pennsylvania Avenue, N.W., Washington, DC 20006
NATIONAL WILDLIFE FEDERATION, 1412 16th Street, N.W., Washington, DC 20036
THE SOCIETY OF AMERICAN FORESTERS, Suite 300, 1010 16th Street, N.W., Washington, DC 20036
SOCIETY FOR RANGE MANAGEMENT, 2120 South Birch Street, Denver, CO 80222
SOIL CONSERVATION SOCIETY OF AMERICA, INC., 7515 NE Ankeny Road, Ankeny, IA 50021
SOIL SCIENCE SOCIETY OF AMERICA, 677 South Segoe Road, Madison, WI 53711
WATER POLLUTION CONTROL FEDERATION, 3900 Wisconsin Avenue, Washington, DC 20016
WILDLIFE MANAGEMENT INSTITUTE, 709 Wire Building, Washington, DC 20025
HE WILDLIFE SOCIETY, Suit S-176, 3900 Wisconsin Avenue, N.W., Washington, DC 20016

H. Potential Resource Persons for Conservation of Natural Resources

A CHECKLIST OF POTENTIAL RESOURCE PERSONS WITHIN A COMMUNITY

The following checklist may be used as a guide to survey community resource people who would be available to assist teachers with planning field trips, to serve as resource speakers or to assist students with individual projects.

I. Local, State, and Federal Resource Person(s)

______ Agriculture Stabilization and Conservation Service Personnel
______ Community Planning Personnel
______ County or Parish Recorder of Deeds
______ Fish Conservation Officer (Warden)
______ Forest Ranger
______ Forestry Service Personnel
______ Game Conservation Officer (Warden)
______ U.S.D.A. Soil and Water Conservation Service Personnel

II. Local, State, and Federal Inspector(s)

______ Building
______ Environmental
______ Mining (Minerals and Metals)
______ Oil and Gas
______ Range
______ Safety
______ Sanitation

III. Supervisors, Managers, and Caretakers

______ Camp grounds
______ Forests
______ Flood Control Facilities
______ Garbage Disposals
______ Historic Sites and Monuments
______ Libraries
______ Museums
______ Nature Trails
______ Power Generating Stations
______ Parks
______ Recreation Facilities
______ Science Centers
______ Sewage Plants
______ Tour Services
______ Water Works
______ Wildlife Sanctuaries
______ Zoos

IV. Community Leaders

______ Clubs
______ Youth Groups
______ Historic Societies
______ Veteran Organizations
______ Government Officials
______ Professional Leaders

I. Other Suggestions

1. It is recommended that teachers who wish to teach a semester course in conservation examine a copy of the conservation text, Patterns For Preservation and the texts accompanying workbook. Both are excellent. Also, there are two magazines, Outdoor Indiana and National Wildlife that are interesting and educational. They can be ordered to supplement classroom instruction in conservation of our natural resources. (See central reference list for addresses).

2. Indiana Conservation Council, Inc., authorized Indiana affiliate of the National Wildlife Federation publishes a monthly newspaper called Hoosier Conservation. This excellent newspaper is dedicated to the wise use and management of Indiana's Natural Resources. Any teacher teaching conservation of Natural Resources will find this publication invaluable for current, update information concerning conservation in Indiana. Even if one is not teaching a unit on Conservation of Natural Resources, this newspaper would be interesting and relevant in every Vo-ag classroom today. Subscription to the Hoosier Conservation is through membership to the Indiana Conservation Council, Incorporated @$5.00. Hoosier Conservation can be ordered from this address: Hoosier Conservation, P.O. Box 672, Muncie, Indiana 47305.

LESSON 1: IMPORTANCE OF CONSERVATION OF NATURAL RESOURCES

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define conservation.
2. Make up a list of five examples of why conservation is important.
3. Define renewable and non-renewable natural resources and list five examples of each.
4. List eight soil and water problems in urban communities.

MOTIVATION:

Discuss the following statements:

> Which is more meaningful: Conservation of our natural resources or the space race?
>
> Why have over two-hundred species of wildlife been exterminated in the past 150 years?
>
> Why are most of the rivers in Indiana brown? Do you think they were always that way?
>
> Why are public camping grounds generally always overflowing?
>
> How does conservation effect you and your family?

Make a list of jobs and careers found in the area of conservation.

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handout: "Conservation Problems Here?" ID-92, Cooperative Extension Service

Slide Set: Conserving our Natural Resource (Purdue A.V. Center)

Transparency Masters: "Lost Farmland"
"Nature's Pantry"

OUTLINE:

A. Definition: Conservation - Is making resources provide for the greatest good for the greatest number for an indefinite period of time.

B. Examples of Why Conservation is Important:

1. 200 species of wildlife have been exterminated in the past 150 years.
2. 1,000 species of wildlife are classified as endangered species.
3. In pioneer times one billion acres of forests were in America. Now it's less than half that. (See transparency #1)
4. In pioneer times our top soil was about 9 inches thick. Today it averages 5 inches thick.
5. Pollution of air and water take up much time in Congress and state legislatures.
6. The world population will double by 2000.

C. What Kind of Natural Resources Are There?

1. Renewable:

   a. Water
   b. Forests
   c. Wildlife
   d. Fish
   e. Air

2. Non-renewable:

   a. Soil (See transparency #2)
   b. Coal
   c. Wilderness
   d. Oil
   e. Natural gas
   f. Iron

D. Eight Problems Urban Communities Have in Soil & Water Conservation (See ID-92 Conservation Problems Here?)

1. Major flooding
2. Inadequate drainage
3. Erosion
4. Improper land use

5. Sedimentation
6. Inadequate water supply
7. Neglected areas
8. Rapid land use change

TEACHING LEARNING ACTIVITIES:

1. Have students make reports on endangered wildlife species found in America. The list may be obtained from the National Wildlife Federation.

2. Make up a list of renewable and non-renewable materials found in the classroom.

3. Have an Indiana State Naturalist (found in many state parks throughout Indiana) speak to the class about the "Importance of Conservation."

4. Take the class on an imaginary trip 100 years into the future and imagine life if no conservation was practiced between now and then.

5. Show the following slide set: Conserving Our Natural Resources (37 slides, 1 guide) - shows the importance of conservaion practices in preserving the soil, grass, water, wildlife, and other natural resources of the land. This can be ordered from the Purdue A.V. Center. Shelf No.'s SL0268 or SL0269.

6. Have students in class give their definitions of conservation.

SUGGESTED EVALUATION:

1. Give the students a quiz over the objectives.

what can swcd's do?

- Provide technical assistance to make and interpret soil surveys. An "inventory" of the soil is essential to insure proper planning of future land and water developments. A survey will show where flooding might occur, where drainage is a problem, where septic tanks won't work, what land is likely to erode, what soils aren't suited for buildings or roads, and similar important facts. With soil surveys as a guide, communities can avoid many costly mistakes as they grow.

- Assist in developing community and multi-county soil and water resources. SWCD's will help sponsor and plan watershed protection and prevention projects and resource conservation and development projects. Such projects are designed to assist communities and multi-county areas in controlling flooding, protecting land from erosion, developing water supplies and creating recreation and wildlife facilities, as well as solving many other soil and water related needs.

- Consult with land users being affected by urban sprawl. SWCD's can help people prepare for this transition by advising them on ways to minimize soil and water problems that can develop during land use changes.

- Provide technical information and recommendations to local government units, community and business groups, and land users who have specific soil and water problems. Such problems may relate to home development sites, industrial sites, recreation areas, farm lands, roads and streets, or sanitation systems. And they can exist on either private or public property.

These, then, are some of the services that Soil and Water Conservation Districts can provide urban communities and their residents. For more information about your local SWCD and what it can do, contact .... the Soil Conservation Service or Cooperative Extension Service in your county.

Prepared in cooperation with the
State Soil and Water Conservation Committee,
Indiana Department of Natural Resources

Rev. 1973 (25M)

ID-92

conservation problems here?

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA

a look at soil and water problems in urban communities

"Conservation problems here? You must be joking? Why, there isn't a farm for miles around. In fact, hardly an open field.

"Look, this is an urban community. What kinds of conservation problems could we possibly have here?"

The answer startles many people.

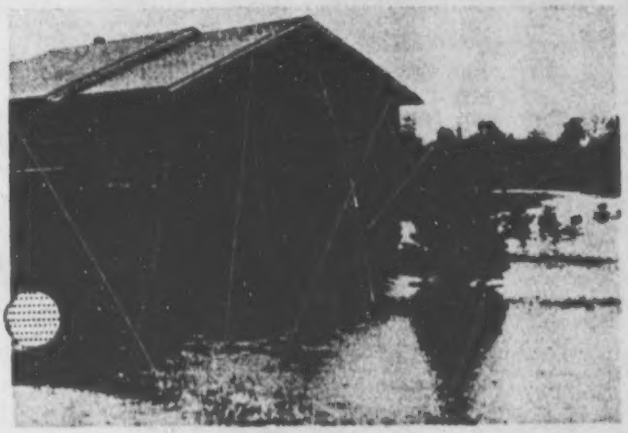
Urban communities have the same soil and water problems that farmers have . . . . and probably a few more. You may not have recognized them as "Conservation" problems or even been aware of them at all. And you probably don't realize what they cost you and your community.

Nevertheless, urban conservation problems are just as real as rural ones, except . . . . they lower property values instead of yields; they stunt economic growth instead of crop growth.

No indeed! The consequences of uncontrolled water or unprotected land don't end at the farmer's fence. They are felt in town as well. Conservation problems exist right off Main Street.

Care to look?

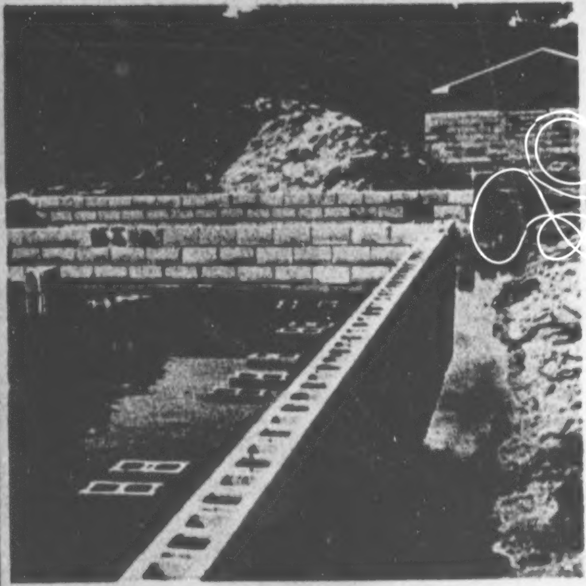
INADEQUATE DRAINAGE
But here's a more common sight. Local flooding! Water that can't soak in and won't run off because of inadequate shaping of the ground to insure good surface drainage.



EROSION
This sight is especially common in areas being developed. It doesn't take long for rain falling on unprotected land to gouge out huge gullies and flush away tons of top soil before permanent grass is established.

MAJOR FLOODING
The desperate battle against swollen streams and rivers is an annual nightmare for dozens of Indiana communities.

SEDIMENTATION
At the other end of an erosion problem is a sediment problem. The soil washed away by uncontrolled water settles on lawns and streets, plugs up streams and reservoirs, and creates a pollution hazard.



IMPROPER LAND USE
Different soils are suited for different uses. Some are best for crops and woodlands; others for ponds, parks and playgrounds; still others for homes, stores and factories. Here's what can happen when soil water table is near the surface . . . .

. . . . or when soil bearing strength and potential slip problems are ignored.

INADEQUATE WATER SUPPLY
Too many communities stop growing because they run out of water, not because they run out of land. Inadequate water supply limits recreation use and development, business expansion, as well as population growth.

NEGLECTED AREAS
Typical of growing communities are scores of neglected areas like this. Ugly, 'abandoned patches of swampy or scarred land that nobody seems responsible for.

RAPID LAND USE CHANGE
Conversion of land from rural to urban uses can create serious problems for a developing area. Too often, land use decisions are made without considering the soil. The results can be permanent as well as costly.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U.S. Department of Agriculture Cooperating H.G. Diesslin, Director, West Lafayette, Indiana.
Issued in furtherance of the Acts of May and June 30, 1914.

help is available

These are just some of the soil and water conservation problems that plague urban communities. There are plenty more.

Individuals and communities can get help in solving their soil and water problems. This help is available throughout the local Soil and Water Conservation District (SWCD).

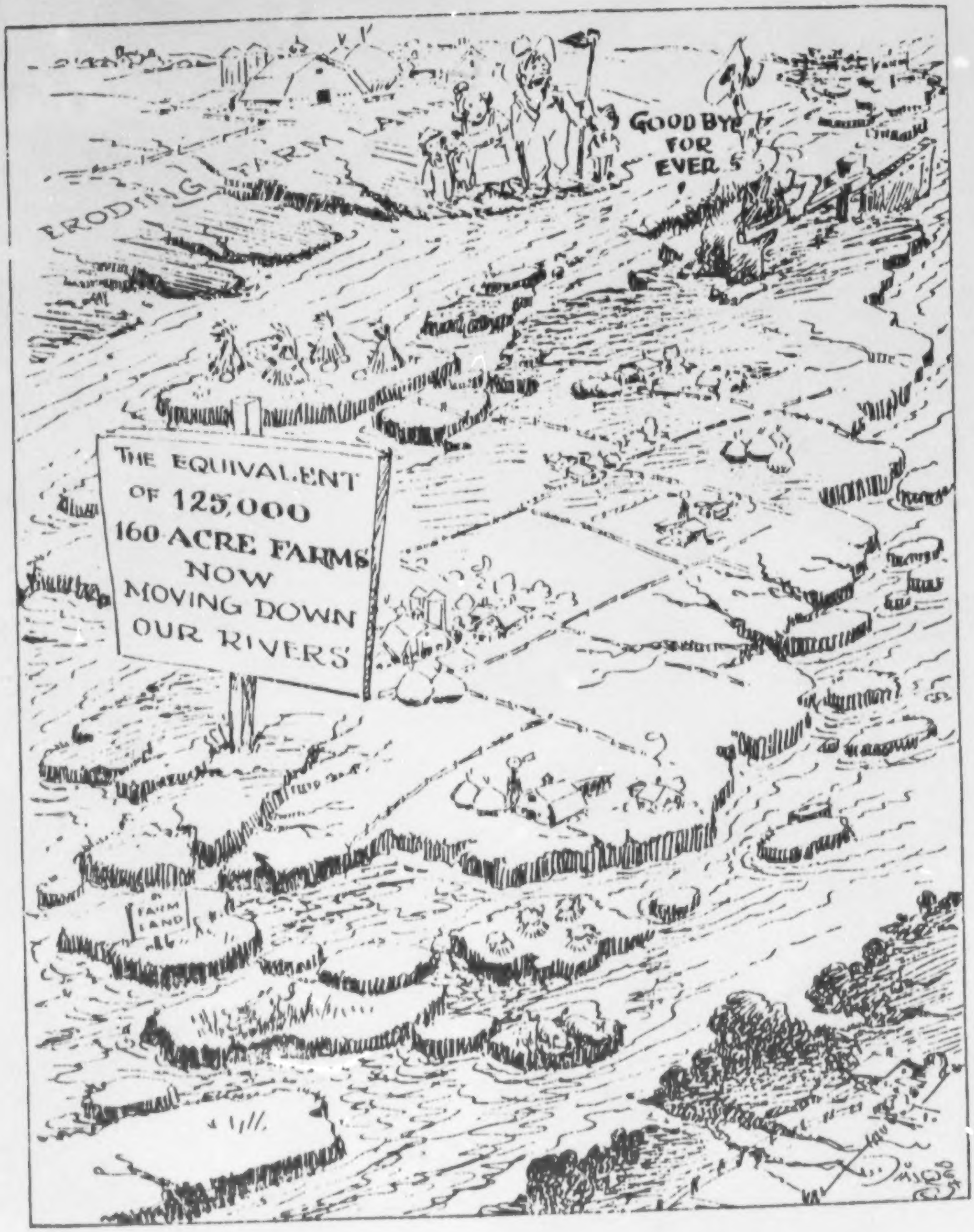
what are swcd's?

A Soil and Water Conservation District is a legal subdivision of state government responsible for leadership in the conservation of soil, water and related natural resources within a county. To fulfill its role, the SWCD works with local government, citizens' groups and individuals to correct existing soil and water problems, to prevent new ones, and to develop the community's natural resources to their proper and fullest use. Through the SWCD, local people are better able to organize and coordinate their efforts and may also call upon many state and federal agencies for technical and financial assistance. Among the agencies aiding SWCD's are:

Indiana Department of Natural Resources
Indiana Department of Commerce (Planning & Research Division)
Indiana Cooperative Extension Service
Soil Conservation Service, U.S. Department of Agriculture

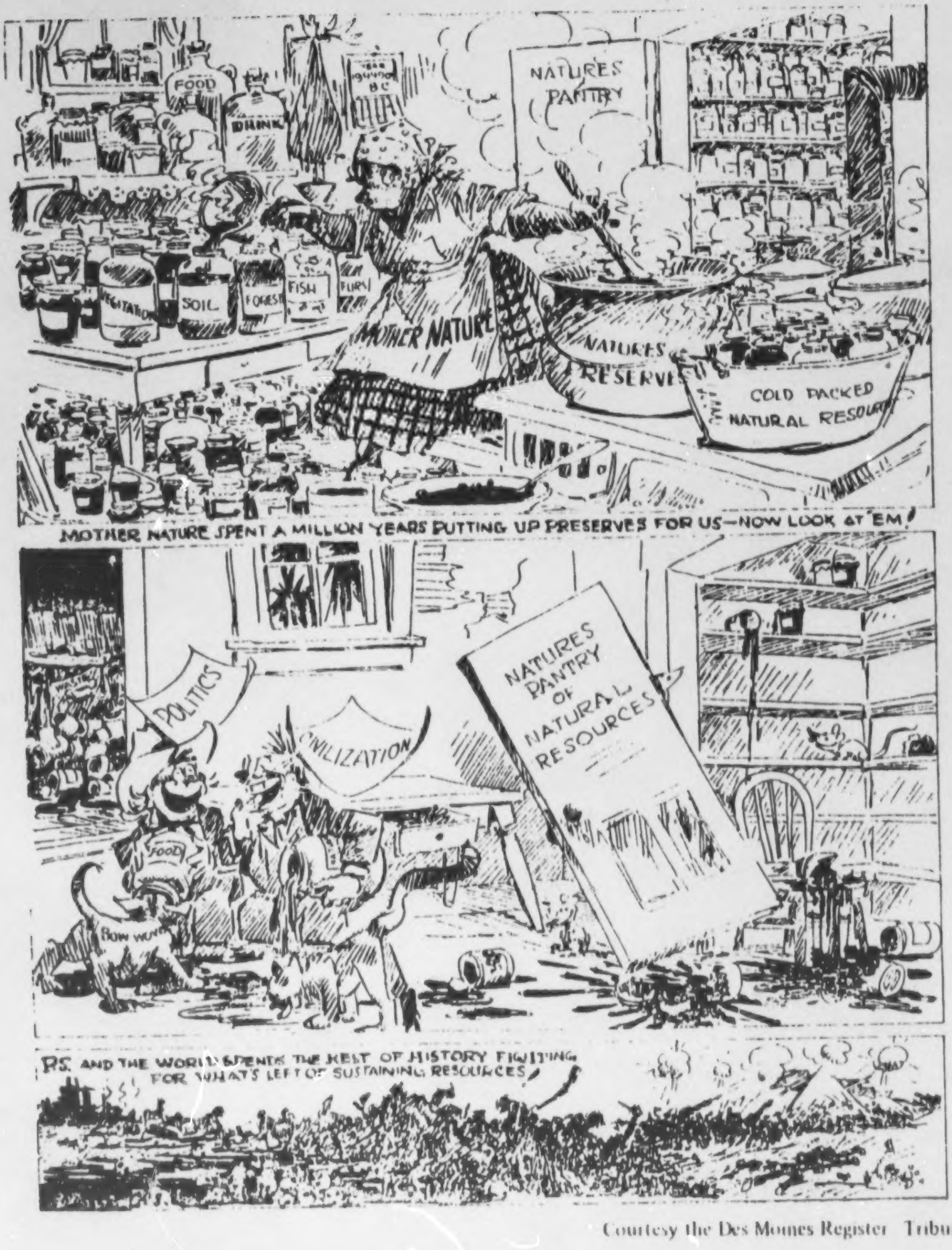
Each district is managed by a board of five supervisors — local residents who become acquainted with the soil and water conservation problems of the area and develop, with local help, a program to correct these problems. These supervisors serve without pay.

SWCD operations are financed through a combination of state appropriations, money earned by the Districts themselves, contributions from private sources, and, in many cases, county assistance.


ERODING FARM LAND
GOOD BYE FOR EVER
THE EQUIVALENT OF 125,000 160-ACRE FARMS NOW MOVING DOWN OUR RIVERS
FARM LAND

Courtesy the Des Moines Register Tribune.

LOST FARMLANDS


FOOD
DRINK
VEGETATION
SOIL
FOREST
FISH
FURS
MOTHER NATURE
NATURES PANTRY
NATURES RESERVES
COLD PACKED NATURAL RESOURCES
MOTHER NATURE SPENT A MILLION YEARS PUTTING UP PRESERVES FOR US—NOW LOOK AT 'EM!
POLITICS
CIVILIZATION
FOOD
BOW WOW
NATURES PANTRY OF NATURAL RESOURCES
P.S. AND THE WORLD SPENDS THE REST OF HISTORY FIGHTING FOR WHAT'S LEFT OF SUSTAINING RESOURCES!

Courtesy the Des Moines Register Tribune.

NATURE'S PANTRY

752

Courtesy of Farm Book Company

LESSON 2: ENVIRONMENT AND ECOLOGY

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define environment.
2. List the three major environments.
3. Define ecology.
4. List two examples of why we study ecology.

MOTIVATION:

1. Have each student describe his home environment.
2. Have the students describe the environment of a pig, cow, horse, ant, flea, etc.
3. Discuss what would happen to us if there were no trees or plants in our world environment.
4. What if a train carrying zoo specimens were to crash (in Indiana) and a breeding pair of hippopotamus were to escape. Do you think they could survive?
5. Long ago, why did some species of animals like the dinosaurs disappear, yet some species survived?
6. Why aren't wild elk, bear or moose found in Indiana? Were they ever?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

OUTLINE:

A. Environment:

1. Any external force, substance, or condition that affects living organisms in any way.

2. The environment is made up of many factors.

   a. Soil factor - parent materials, organic matter, soil elements, development
   b. Water factor - atmospheric moisture, precipitation, soil moisture, water use by organisms
   c. Temperature factor - variations of temperature affecting plants and animals
   d. Light factor - variations of light affecting plants and animals
   e. Atmospheric factor - the gas composition, winds and pollution problems
   f. Biotic factor - how animals and plants affect each other and are specialized for certain conditions
   g. Fire factor - how fire regulates and changes the make-up of plants and animal habitats

B. Three Major Types of Environments:

1. Land environment.

2. Fresh water environment.

3. Salt water environment.

C. Ecology: Study of the interactions that determine the distribution and abundance of organisms. (A study of relationships of living things.)

D. Reasons for Studying Ecology:

1. To clearly define a widely used term often misunderstood by people.

2. To study the way living things interact with each other and thus give insight into what will take place when man alters the environment for a given area.

3. To help man understand how interactions in living organisms work for the control and survival of these organisms.

E. Two Examples of Ecological Relations:

1. A change in plant population resulted in a change in animal numbers.

   a. 1921 estimated white tail deer population at 300,000
      1967 estimated white tail deer population at 15 million

b. 1921 forest conditions - many heavy canopied forests, restricting growth of browse type plants

1967 increased human population and more development would seem to limit deer population. Due to harvest of timber causing openings in the over-story brought development of more food plants for deer.

2. Symbiotic relationships:

   a. Scientists could not determine how termites could digest fiber in their simple digestive system
   b. An examination of protozoa led to the discovery that the microcopic animal living in the termite digested the fiber providing the broken down material for the termite
   c. The animals were benefitting each other.

TEACHING LEARNING ACTIVITIES:

1. Capture some termites and examine their stomach contents under a microscope. Note the protozoa.

2. Bring in two pine seedling, one a young white pine and the other a young red pine. Place them both in sunlight- You will discover that sunlight inhibits the growth of young white pines but accelerates growth in red pine. Tolerance for shade is critical in young white pine.

3. Have the students discuss what ecology and environment means to them.

4. Have each student give an example of the environment of a different animal.

SUGGESTED EVALUATION:

1. Give the students a quiz over the objectives.

LESSON 3: PLANT SUCCESSIONS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Write a definition for succession.
2. List the five stages of a typical plant succession.
3. List two reasons why plant successions are important.
4. List four factors that affect plant successions.

MOTIVATION:

Discuss the following statements:

1. Which came first, plants or animals?
2. Suppose you walked away from the lawn around your house for 100 years. Also suppose no one would ever do anything to the lawn i.e., no watering, no fertilizing, no mowing, no weeding, no nothing. What would happen? In 150 years? In 200 years?
3. What would happen if you lived in a desert, and watered your lawn regularly before going away for 100 years? 150 years? 200 years?

Point out that the changes that occur are forms of plant succession.

REFERENCES:

Patterns in Preservation, National Farm Book Company.

Transparency Master: "Plant Successions"

OUTLINE:

A. Define succession: The overall process of one plant or combination of plants replacing one another for environmental reasons. The final plant succession for a given area is called "a climax".

B. Five stage of a typical plant succession: (see transparency master 3)

   1. Bare soil
   2. Annual weeds

3. Perennial weeds

4. Shrubs

5. Forest climax

NOTE: This is true generally for Indiana, but for an area like Kansas, the plant succession climax would be prairie grass, or an area in the rockies might have a climax community of Ponderosa Pine.

C. Importance of Plant Succession:

1. The plant community must always preceed the animal community.

2. Different species of wildlife live in different plant succession stages. For example: squirrels live in a forest climax and not annual or perenial weeds.

D. Factors that Effect Plant Succession:

1. Man - farming, clear-cutting forest, chemicals, etc.

2. Fire - destroys plants

3. Disease - kills plants

4. Pests and animals - eat all the available forage inviting erosion and flooding

TEACHING LEARNING ACTIVITIES:

1. After the motivation, discuss with the students how they might define plant succession. Show the transparency in Plant Succession.

2. Refer back to motivation discussion and review how plants will change in an ordered sequence. Ask why and how plant succession takes place. Tie into the discussion the shade tolerance ideas and climate factors.

3. Ask students to explain why plant succession is an important consideration to include while studying conservation of natural resources.

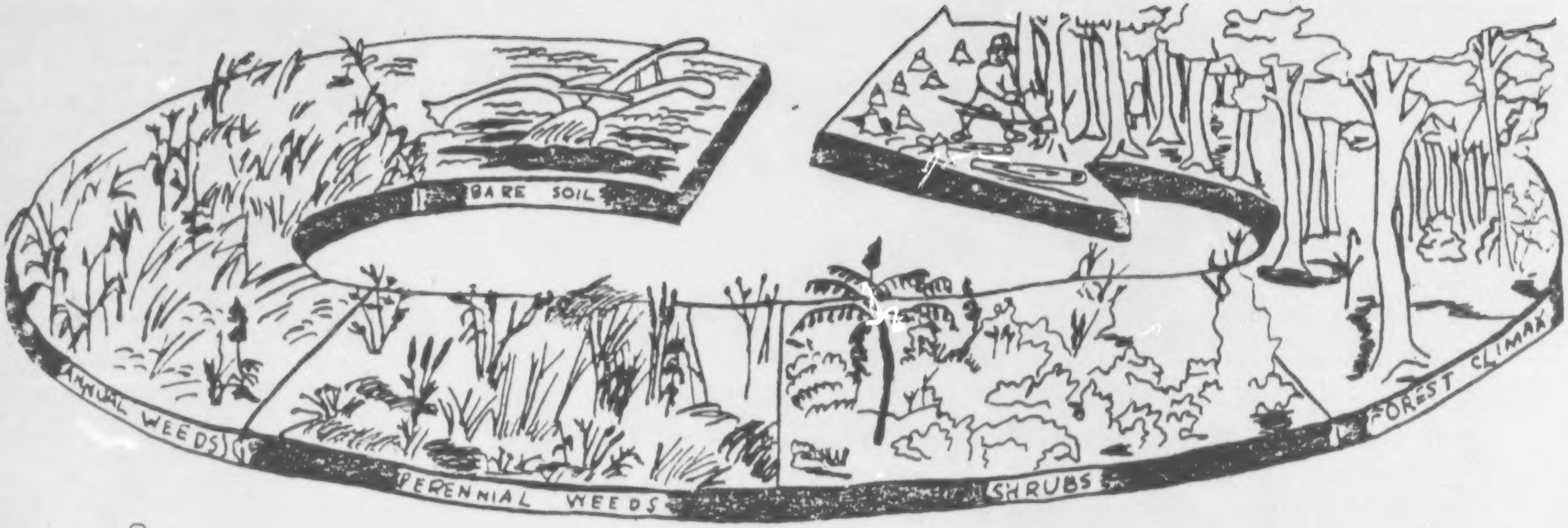
4. Have the students make a list of wildlife that inhabit different successional stages. Some overlapping may occur.

5. Discuss how man interrupts succession and can change wildlife populations simply by changing the plant species in an area. Discuss other ways.

6. Take a field trip to several places in the community. Lead discussion on identifying the succession stage. Ask the students why the succession is in a certain stage at each step.

SUGGESTED EVALUATION:

1. Give the students a quiz over the objectives.
2. At one point on field trip have each student write down the successional stage and why it is in that stage. Assign grades to their answers.


BARE SOIL
ANNUAL WEEDS
PERENNIAL WEEDS
SHRUBS
FOREST CLIMAX

PLANT SUCCESSIONS

Courtesy of Farm Book Company

LESSON 4: FOOD WEBS (FOOD CHAINS)

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define predator and list five examples of predators.
2. Write out a food web starting with a great horned owl.
3. List two examples of cause and effect of cycles in wildlife populations.
4. List the reasons that the food choice in a diet of animals living in the far north is smaller than the food choice in a diet of animals located in a more temperate climate.

MOTIVATION:

1. Make a list of everything a black bear might feed on. (Things to look for: fish, carrion, rodents, insects, fruits, vegetation, berries.)
2. Make a list of everything a polar bear might feed on. (Things to look for: seals, washed up whale.) Why the difference?
3. Make a list of everything a fox might eat. Wolf? Owl? Etc.
4. Discuss whether or not there are any bad animals in conservation.

REFERENCES:

1. Patterns for Conservation, National Farm Book Company.
2. The Cottontail - film, Purdue A.V. Center

OUTLINE:

A. Define predator: An animal that feeds mainly on other animals.

   1. Examples of predators:

      a. Fox
      b. Wolf
      c. Owl
      d. Man
      e. Largemouth bass

B. Four Diagrams Illustrating Food Webs: (see the following transparencies)

1. Transparency Master #4: Game Pyramid
2. Transparency Master #5: Fish Food Chain
3. Transparency Master #6: Fish Food Chain
4. Transparency Master #7: Wildlife Food Web

C. Examples of Cause and Effect of Cycles in Wildlife Population:

1. Lynx (a bobcat type animal) and hare (rabbit) populations. In 1885 the hare population was 135,000 (estimated from the number of pelts recorded by Hudson Bay Co.) while at the same time trappers brought in 70,000 lynx pelts. Five years later only 50,000 hares were pelted and only 7,500 lynx pelted. Then five years later (1895) when hare pelts increased to 90,000 the lynx pelts increased to 55,000.

2. Fox and lemming. Studies have shown that a sharp drop in fox pelts recieved by the Hudson Bay Co. can be correlated directly with an earlier drop in the number of lemmings. When the food source drops, and in areas like the far north where alternate sources are hard to come by, the predator dies as relentlessly as does the preyed upon.

D. Knowing the Following Information:

1. Black Bear Diet: Fish, honey from a bee tree, carrion, grubs, fruit, rodents, berries, vegetation, and insects.
2. Polar Bear Diet: Seals and carrion

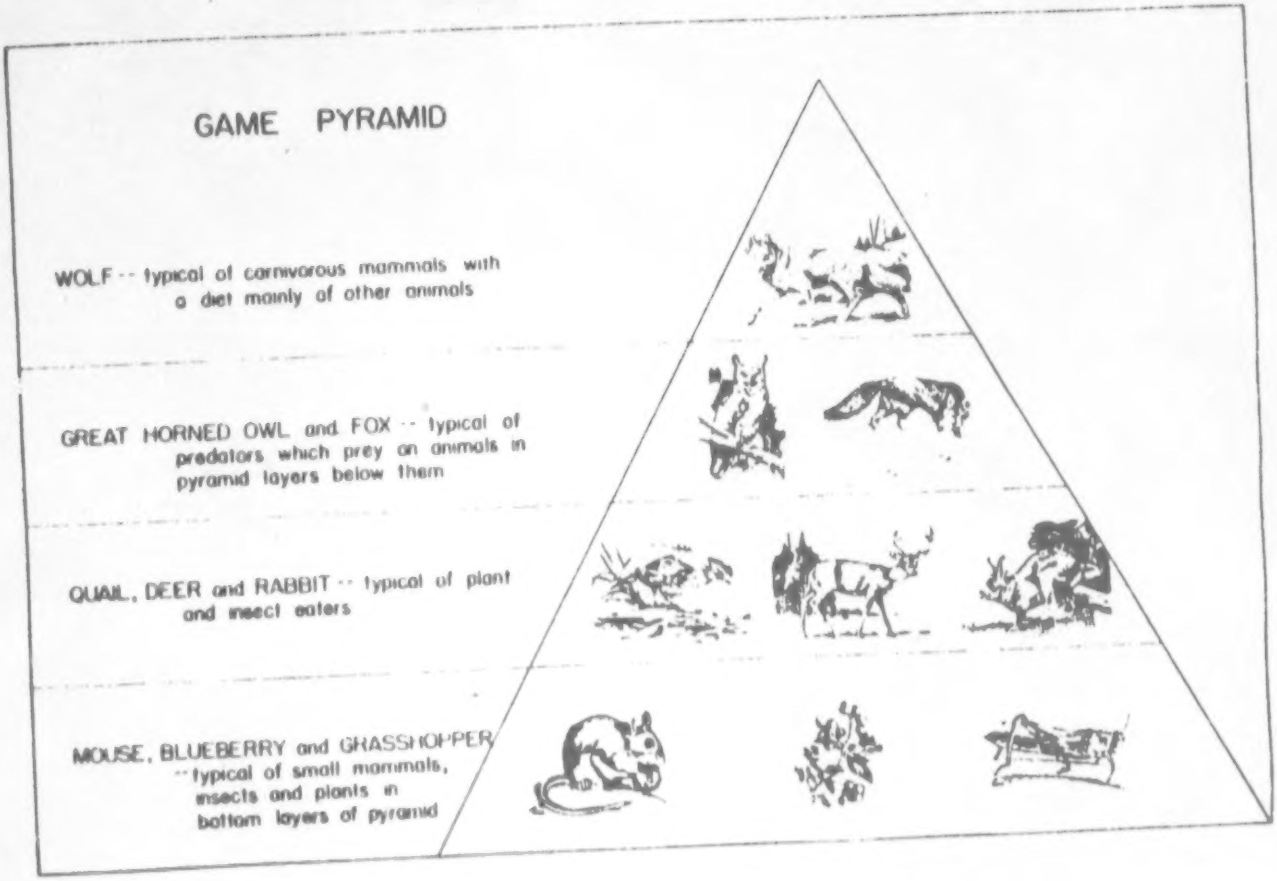
Why is the Black Bear Diet larger? Answer: There are very few food sources in far northern areas, because fewer plants and animals are able to successfully adapt to the environment.

TEACHING LEARNING ACTIVITIES:

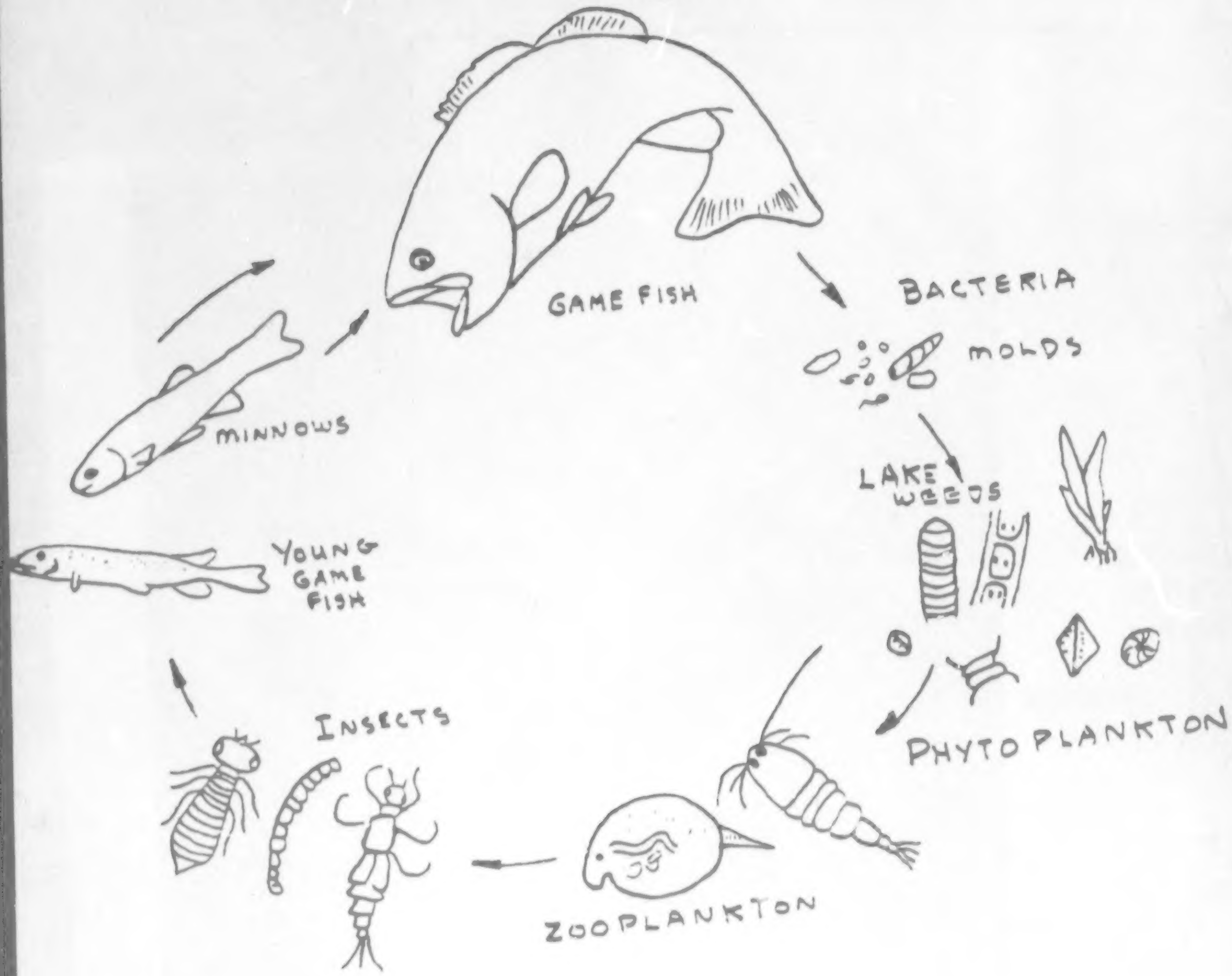
1. Make up a food web in class, starting with man at the top.
2. Make up an example of a food web in class by cutting out pictures of animals from old magazines and putting them on a bulletin board.
3. Show the motion picture, The Cottontail (53 minutes). Follows a cottontail rabbit family through the season and depicts its link in natures chain of life, a creature preyed upon by almost every meat eater, including man and his pets. Location Purdue A.V. Center, Shelf No. MP2693. (This film is very strongly recommended.)

SUGGESTED EVALUATION:

1. Give the students a quiz over the objectives.

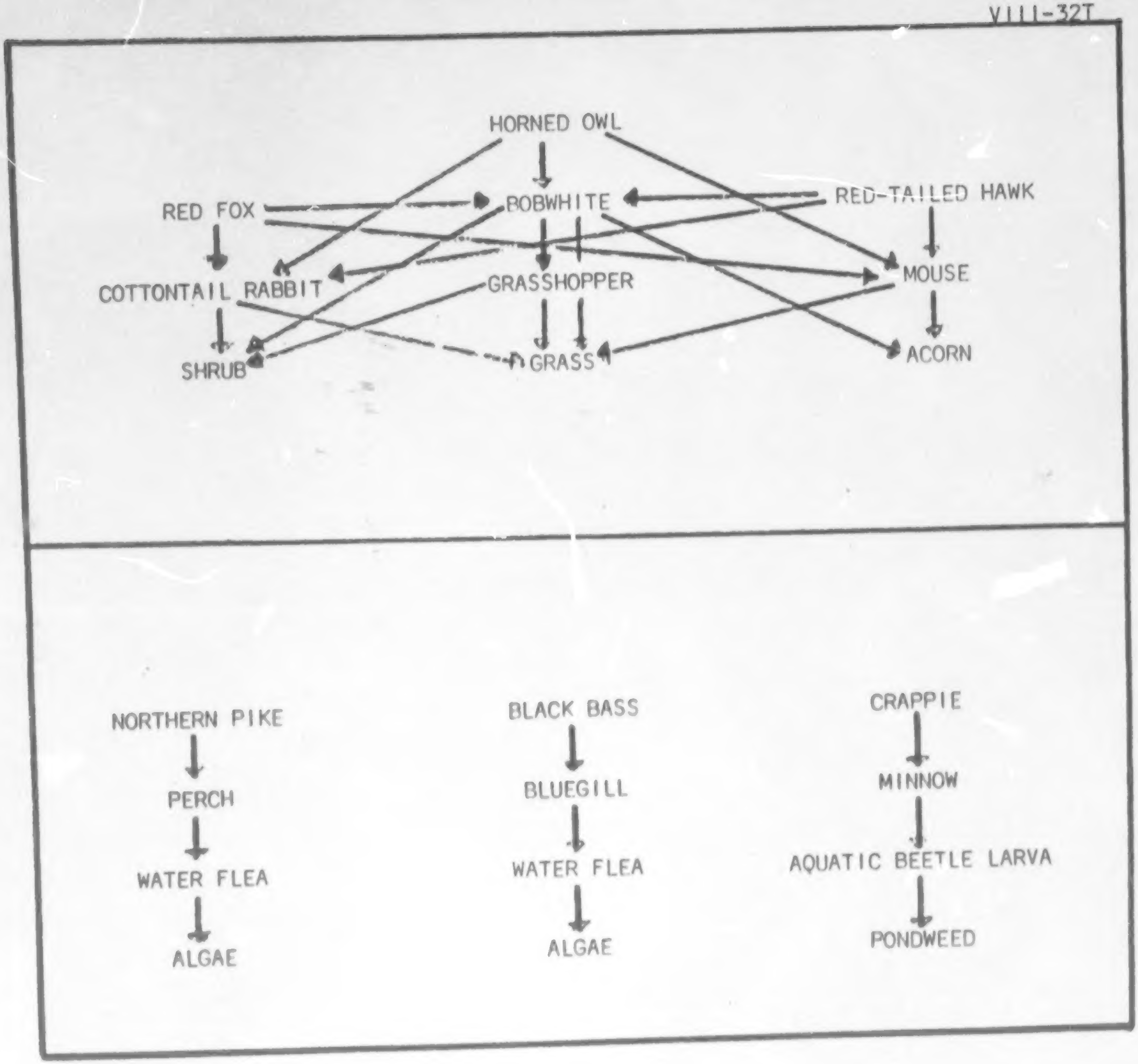

GAME PYRAMID
WOLF -- typical of carnivorous mammals with a diet mainly of other animals
GREAT HORNED OWL and FOX -- typical of predators which prey on animals in pyramid layers below them
QUAIL, DEER and RABBIT -- typical of plant and insect eaters
MOUSE, BLUEBERRY and GRASSHOPPER -- typical of small mammals, insects and plants in bottom layers of pyramid

Courtesy of Farm Book Company


GAME FISH
BACTERIA
MOLDS
LAKE WEEDS
PHYTO PLANKTON
ZOOPLANKTON
INSECTS
YOUNG GAME FISH
MINNOWS

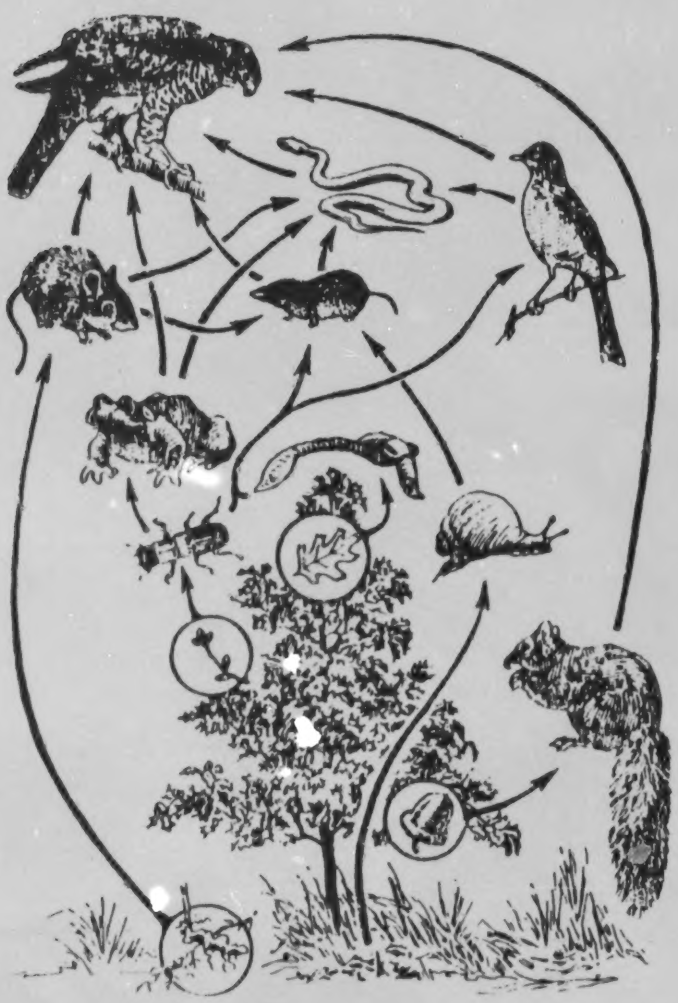
FISH FOOD CHAIN

Courtesy of Farm Book Company


HORNED OWL
RED FOX
BOBWHITE
RED-TAILED HAWK
COTTONTAIL RABBIT
GRASSHOPPER
MOUSE
SHRUB
GRASS
ACORN
NORTHERN PIKE
PERCH
WATER FLEA
ALGAE
BLACK BASS
BLUEGILL
WATER FLEA
ALGAE
CRAPPIE
MINNOW
AQUATIC BEETLE LARVA
PONDWEED

FISH FOOD CHAIN

Courtesy of Farm Book Company



WILDLIFE FOOD WEB

Courtesy of Farm Book Company

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LESSON 5: RECREATION AND SCENERY

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. List five common types of recreation areas.
2. List the four most common recreational activities.
3. List four reasons of importance of scenery.
4. List four threats to scenic areas.
5. List five ways to preserve scenic areas.
6. List three problems associated with recreation and scenery.
7. List the five agencies in Indiana with principal responsibilities in outdoor recreation.

MOTIVATION:

1. Have each student tell about their favorite outdoor recreation. Next, ask them if it will always remain possible without the practice of conservation.
2. I'm sure all the students have heard the expression, "This is God's country," referring to the scenery in various areas. Have each student tell about the place of scenic area or his idea of the area when one says, "This is God's country."
3. Why do people take vacations?
4. Would you like to go to school 365 days a year?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Indiana Outdoors, July & August 1977

Outdoor Recreation in America, Burgess Publishing Company

Transparency Masters:
"Litter in our Public Parks"
"Here Come the Nature Lovers"

Handout: "Indiana's 120 State Access Sites and our 15 State Fishing Areas"

OUTLINE:

A. Five Types of Public Recreation Areas:*

1. National parks
2. National forests
3. State parks
4. State forests
5. Community parks

*There are many more than five types of recreation areas, these are five common ones.

B. The Four Most Common Activities Ranked in Order of Importance: (see transparency master)

1. Swimming - 52% U.S. population over 12 years old.
2. Picnicking - 46% U.S. population over 12 years old.
3. Sightseeing - 37% U.S. population over 12 years old.
4. Pleasure Driving - 34% U.S. population over 12 years old.

C. The Importance of Recreation and Scenery (Values):

1. Recreational values:
    a. Hike, hunt, fish
    b. Skiing, boating, horseback riding, swimming, picnicing, etc.
    c. Photography
2. Economic values:
    a. Sale of equipment, food, cafeterias
    b. Fringe business (models, stables, ski lodges)
3. Intangible values:
    a. Spiritual, esthetic, sense of wonder
    b. Appreciation
    c. A change from the city, an altered view
4. Educational values:
    a. Archeology
    b. Nature study
    c. Ecology, geology, zoology, botany, etc.

D. Threats to Scenic Resources:

1. From the public:
    a. Litter, vandalism, theft
    b. Fire
    c. Saturation by human numbers
    d. Mechanization and noise

2. From natural forces:
    a. Erosion, quakes, tornadoes
    b. Fire, wind, floods
    c. Pests, over browse

3. Government agencies and authorities:
    a. New roads
    b. Development
    c. Building dams
    d. Drainage (everglades)

4. From commercial interests:
    a. Power lines, natural gas lines, oil pipes
    b. T.V. and radio towers
    c. Billboards, junkyards, dumps

E. How to Preserve Scenic Areas:

1. Acquire the area:
    a. Gifts, grants, wills
    b. Cash purchase

2. Fight to keep it:
    a. From physical encroachment
    b. Wrong attitudes
    c. Fire protection

3. Build attitudes:
    a. Educate the people not to spoil the view, atmosphere or setting

4. Keep atmosphere natural:
    a. Naturalness

5. Encourage city and private preservation

F. Problems Associated With Recreation and Scenery:

1. Litter (see transparency master)

   a. This problem could be solved by educating the public against littering and making laws that stiffly fine people who litter

2. Conflicting use:

   a. Should cities take park lands for expressways and parking lots?
   b. A church is proposed for the rim of the Grand Canyon, do we go ahead with construction?
   c. A reform school for boys is built in a state forest.
   d. A housing development now has pinched in on historic Gettysburg Battlefield

3. Crowds (see transparency master)

   a. Who wants them?
   b. What can they do?
   c. How do they happen?
   d. What can be done?

G. Five Agencies in Indiana with Principal Responsibilities in Outdoor Recreation that are Under the Indiana Department of Natural Resources:

1. Division of Fish and Game

2. Division of Forestry

3. Division of State Parks

4. Division of Resevoir Management

5. Division of Outdoor Recreation

TEACHING AND LEARNING ACTIVITIES:

1. Have students make a list of types of recreation areas. Discuss the basic types of areas including their uses and who controls or is responsible for them.

2. From the previous discussion ask students what recreation activities are most popular. Place list on board and ask students to rank the types of recreational activities in order of popularly. Show transparency on ranking of recreational activities.

3. Relate the importance of scenery to discussion of recreational activity & how a lot of recreation is tied to scenery. Ask class about other ways the scenery is important. See the outline for information.

4. What types of areas are preserved specifically for scenery? (Parts of National Forests, National and State Parks, Wilderness Areas) Particular scenic views. Divide class in groups and have each group decide what are some threats to the natural scenic areas. Have each group report. Combine information into the outline for general areas.

5. Give each group a scenic area and have them decide what is the best use for it.

   a. A river that is used for canoeing and has few houses on it is being planned into a reservoir project for needed electricity. Ask students to list things that should be considered in planning its use.
   b. A forested area is to be logged off. It has some very old walnuts in the stand.
   c. A new road is being planned through part of a national forest that is being used as a wilderness area.
   d. A group of people in a nearby community wants more roads into a scenic area so more people are able to observe the beauty of the area. Another group wants it to be left completely natural. It is a very large area and is used for wilderness hiking. You must decide on the best one.

   (for other ideas see outline F)

6. Have students present their decisions and discuss each situation with the rest of the class. Talk about compromises and the multiple use concept. Discuss ways to preserve scenic areas (see outline).

7. Discuss the affect crowds have on scenic areas. Refer to a state park or other "tourist attraction in your area." Show transparencies on crowds to aid in discussion.

8. Ask students what state agencies are involved in outdoor recreation. Discuss the responsibilities of each agency.

9. Invite a park administrator to talk to class about problems in management of people in parks and how parks are planned.

10. What scenic and recreation areas are available in Indiana? Write to the agencies listed in the outline in part G.

11. Make a field trip to study the facilities and managerial aspects of a state park.

12. Make a field trip to several private outdoor recreational enterprises such as campgrounds, shooting preserves, fishing areas, and water spots.

13. Survey available outdoor recreational facilities within the school district.

14. Survey recreational needs in an area.

15 Inventory the school district to determine what possibilities exist for a recreational enterprise.

16. Inventory a given piece of land and propose the development of a recreational enterprise on it.

17. Design a brochure for a campground.

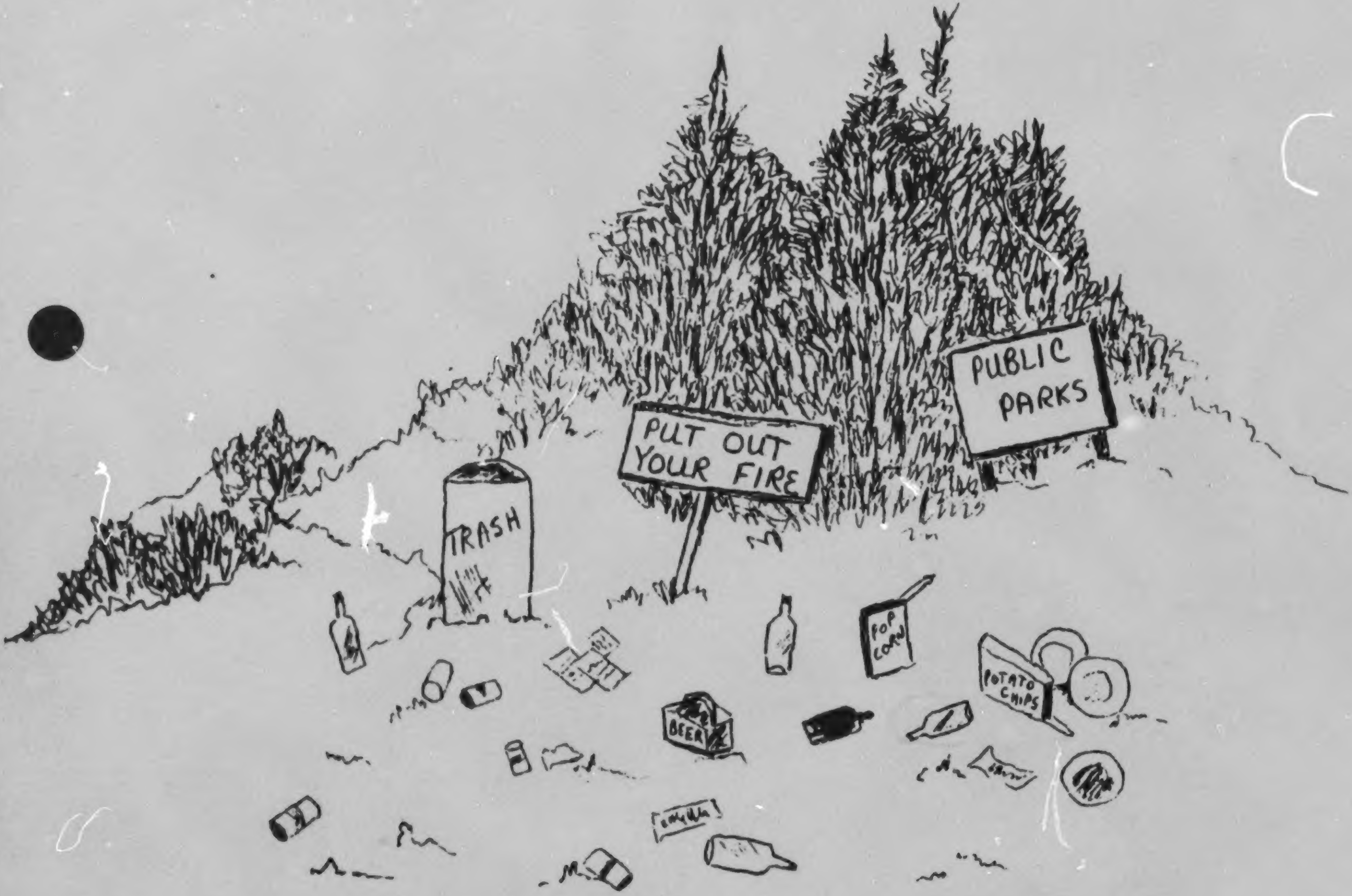
18. Discuss the potential risks and liabilities associated with the operation of a recreational area.

19. Prepare a workable plan for the maintenance of a developed campground or picnic area including:
    a. upkeep of the facilities
    b. provisions of services
    c. maintenance of roads and trails
    d. maintenance of vegetation
    e. reduction of all forms of hazzards

SUGGESTED EVALUATION:

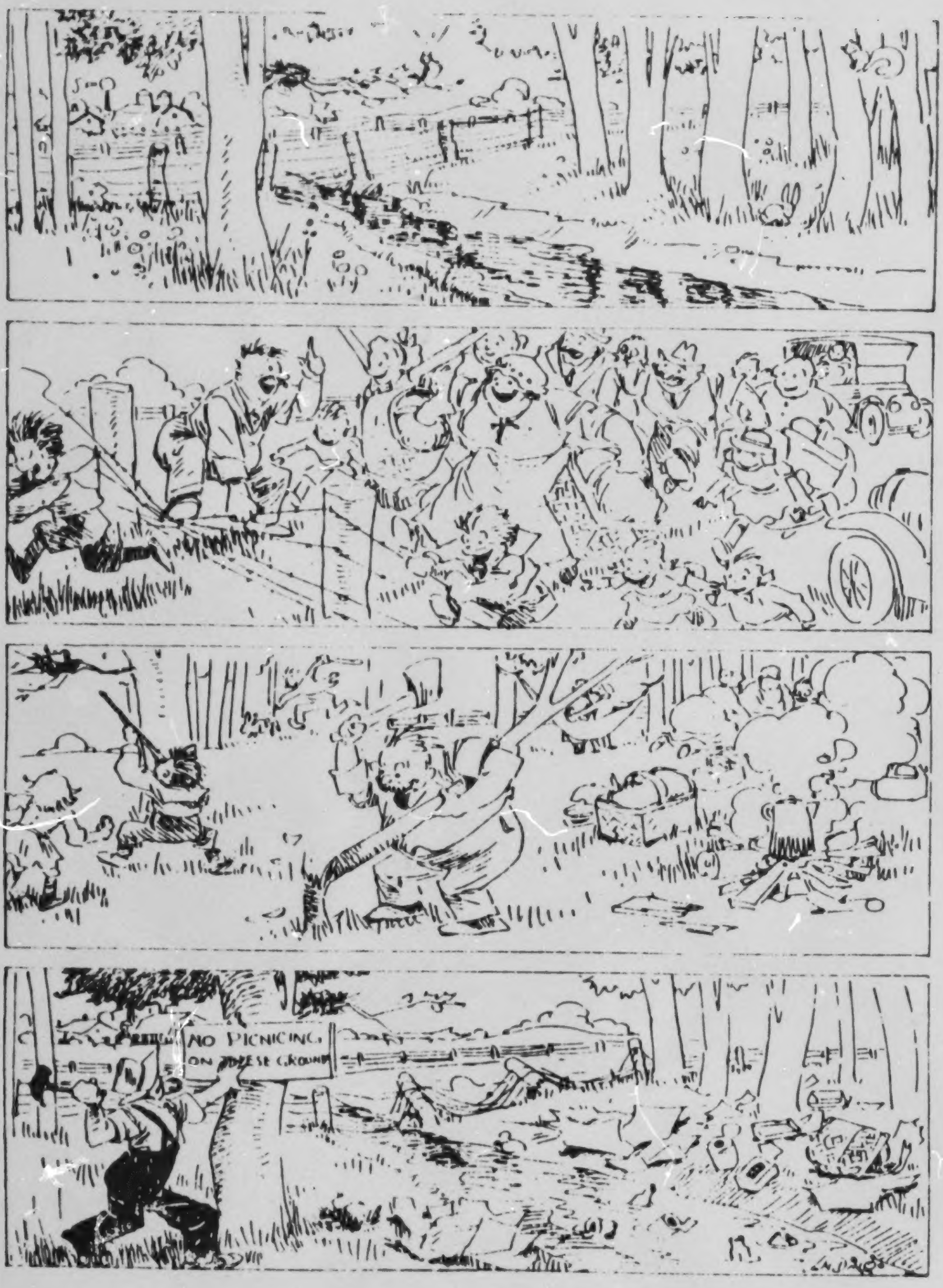
1. Assign grades to group activity.

2. Quiz students on the objectives.


PUBLIC PARKS
PUT OUT YOUR FIRE
TRASH
POP CORN
POTATO CHIPS
BEER

LITTER IN OUR PUBLIC PARKS

Courtesy of Farm Book Company


NO PICNICING
ON THESE GROUNDS

Here Come The Nature Lovers

Courtesy Des Moines Register Tribune

Courtesy of Farm Book Company

INDIANA'S 120 STATE ACCESS SITES
AND OUR 15 STATE FISHING AREAS

INDIANA PUBLIC FISHING SITES

Name of Site	County	Available Acres of Water	Location of Site
Azalia Bridge	Bartholomew	East Fork-White River	Azalia Bridge
Columbus	Bartholomew	East Fork-White River	City of Columbus
Mill Race Park	Bartholomew	East Fork-White River	City of Columbus
Lowell Bridge	Bartholomew	Driftwood River	South of New Bridge
Laughery Creek	Dearborn	Laughery Creek	Old Ford Road
Elnora	Daviess	West Fork-White River	5 miles NW of Elnora
Glendale-White River	Daviess	East Fork-White River	Glendale Fish & Wildlife Area
Portersville Bridge	Daviess	East Fork-White River	1 mile NE of Portersville
Worthington	Greene	West Fork-White River	2 miles E of Worthington, S.R.
Story Lake	DeKalb	77	East shore of lake
Jasper-Patoka River	Dubois	Patoka River	Highway 164 S. edge of Jasper
Fish Lake	Elkhart	34	North shore along road
Simonton Lake	Elkhart	282	South shore of channel
Bristol	Elkhart	St. Joseph River	Apollo St., Bristol
Yellow Creek Lake	Elkhart	20	West side of lake
Six Span Bridge	Elkhart	St. Joseph River	Jct. St. Rd. 120 & Co. Rd. 17
Fletcher Lake	Fulton	43	North side of lake
Manitou	Fulton	713	East shore of lake
Talma	Fulton	Tippecanoe River	1/2 mile west of Talma
Nyona Lake	Fulton	104	North shore of lake
South Mud Lake	Fulton	94	4 miles NE of Fulton
Ohio River	Harrison	Ohio River	Harrison-Crawford State Forest
Brownstown	Jackson	East Fork-White River	2 miles W on Highway 50
Seymour	Jackson	East Fork-White River	1/4 mile W Rockford off Highway 31A
Crosley-Muscatatuck	Jennings	Mascatatuck River	Crosley Fish & Wildlife Area
Atterbury-Sugar Creek #1	Johnson	Sugar Creek	Atterbury Fish & Wildlife Area
Atterbury-Sugar Creek #28	Johnson	Sugar Creek	Atterbury Fish & Wildlife Area
Carr Lake	Kosciusko	64	West shore, north end
Chapman Lake	Kosciusko	435	South shore, Big Chapman
Grassy Creek	Kosciusko	1,459	Leesburg-Oswego Road
Backwaters-Webster Lake	Kosciusko	585	1 mile SE North Webster
Palestine Lake	Kosciusko	232	State Road #25 Palestine
Syracuse Lake	Kosciusko	3,182	North of Railroad Station
Beaver Dam Lake	Kosciusko	146	East side of lake
Mollenhour	Kosciusko	Tippecanoe River	2 miles S of Etna Green

INDIANA PUBLIC FISHING SITES (continued)

Name of Site	County	Available Acres of Water	Location of Site
Vincennes	Knox	Wabash	City of Vincennes
Adams Lake	LaGrange	293	East side of lake
Appleman Lake	LaGrange	52	North shore of lake
Atwood Lake	LaGrange	170	5 miles NW Wolcottville
Cedar Lake	LaGrange	120	4 miles NE Howe
Emma Lake	LaGrange	42	Emma-Topeka Road
Fish Lake	LaGrange	145	Plato-Wolcottville Road
Little Turkey Lake	LaGrange	124	SE end of lake
Oliver Lake	LaGrange	371	North shore of lake
Pretty Lake	LaGrange	185	West side of lake
Scott	LaGrange	Pigeon River	Town of Scott
Shipshewana	LaGrange	202	South shore of lake
Wall Lake	LaGrange	141	South shore of lake
Whitmer Lake	LaGrange	204	1 mile NW Wolcottville
Westler Lake	LaGrange	652	Near channel between Westler and Whitmer
Cedar Lake	Lake	281	North side of lake
Hog Lake	LaPorte	59	2 1/2 miles north of Rolling Prairie
Kingsbury-Kankakee	LaPorte	Kankakee River	Kingsbury Fish & Wildlife Area
Kankakee	LaPorte	Kankakee River	1/2 mile W. Jct. 8 & 39
Trail Creek	LaPorte	Trail Creek	Michigan City
Lawrenceport	Lawrence	East Fork-White River	2 miles NE Lawrenceport
Bedford	Lawrence	East Fork-White River	2 miles S. Bedford on Highway 50
Maxinkuckee Lake	Marshall	1,854	South shore of lake
Lake of the Woods	Marshall	416	West shore of lake
Mill Pond Lake	Marshall	168	West end of lake
Lawrence Lake	Marshall	61	East side of lake
Henderson Bridge	Morgan	West Fork-White River	6 miles NE of Martinsville
Old Tip Town	Marshall	Tippecanoe River	1 mile North of Tippecanoe
Cree Lake	Noble	58	West side lake - St. Rd. 3
Crooked Lake	Noblw	206	West shore of lake
Diamond Lake	Noble	96	East end of lake
Dukes Bridge	Noble	N. Branch-Elkhart R.	4 miles NE Wawaka
Indian Village Lake	Noble	12	St. Rd. 5 at Indian Village
Knapp Lake	Noble	88	North shore of lake
Mallard Roost #1	Noble	Elkhart River	3 miles SW of Wawaka
Mallard Roost #2	Noble	Elkhart River	2 miles West of Wawaka
Mallard Roost #3	Noble	Elkhart River	2 miles SE of Diamond Lake
Sylvan Lake	Noble	630	Rome City-adjoining dam

Name of Site	County	Available Acres of Water	Location of Site
Sparta	Noble	31	East side of lake
High Lake	Noble	123	2 miles SW of Wolf Lake
Spencer	Owen	West Fork-White River	1 mile SE of Spencer
Anderson	Perry	Anderson River	1 mile north of Troy
Tell City	Perry	Ohio River	City of Tell City
Bass Pit	Pike	22.7	Patoka Fish & Wildlife Area
Troy	Perry	Ohio River	City of Troy
Port of Indiana	Porter	Lake Michigan	Port of Indiana
Dogtown Ferry	Posey	Wabash River	8 miles NW of Mt. Vernon
New Harmony	Posey	Wabash River	City of New Harmony
Haschell Bridge	Pulaski	Tippecanoe River	4 miles NE of Winamac
City of Winamac	Pulaski	Tippecanoe River	4 miles South of Winamac
Raccoon Creek #1**	Putnam	Raccoon Creek	St. Rd. 236, 1-1/2 miles W. St. Rd. 43
Raccoon Creek #2**	Putnam	Raccoon Creek	4 miles SE of Raccoon
Batesville Reservoir	Ripley	200	East of Batesville
City of Shelbyville	Shelby	Big Blue River	City of Shelbyville
Bass Lake	Starke	1,345	West side of lake at dam
Ball Lake	Steuben	87	West end of lake at inlet
Beaver Dam Lake	Steuben	20	West shore of lake
Big Turkey Lake	Steuben	450	West shore of lake
Clear Lake	Steuben	800	South shore of Terrace Gardens
Fish Lake	Steuben	59	West shore of lake
Golden Lake	Steuben	119	South side of lake
Lime Lake	Steuben	376	On channel between Lime and Gage Lakes
Little Turkey Lake	Steuben	58	1-1/2 miles West of Hudson
Otter Lake	Steuben	118	U.S. 20-7 miles East of Angola
Pigeon Lake	Steuben	61	West end of lake
Loon Lake	Steuben	138	North shore of lake
Big Bower	Steuben	35	West side of lake
South Bend	St. Joseph	St. Joseph River	NW of South Bend
Pleasant Lake	St. Joseph	29	West side of lake
South Lake	St. Joseph	8	1/2 mile West of Pleasantville Green-Sullivan State For
Fox Lake	Steuben	142	SE side of lake
Downing	Sullivan	12	2 miles South of St.Rd. 64 Green-Sullivan State Forest
Pond No. 1	Sullivan	3	2-1/2 miles South of Dugger
No. 26 Reservoir	Sullivan	50	3-1/2 miles South of St.Rd. 64 Greene-Sullivan State Forest
Merom	Sullivan	Wabash River	Town of Merom

INDIANA PUBLIC FISHING SITES (continued)

Name of Site	County	Available Acres of Water	Location of Site
Clinton	Vermillion	Wabash River	City of Clinton
Old Mill Site	Wabash	Eel River	St. Rd. 16 West of Roann
Bear Grass	Wabash	Eel River	Eel R. Bridge on St. Rd. 15
Laketon	Wabash	Eel River	Laketon
Wabash	Wabash	Wabash River	City of Wabash
Liberty Mills	Wabash	Eel River	1/2 mile South of Liberty Mills
White-Muscatatuck	Washington	White-Muscatatuck River Jct.	3 miles West of Millport
Millport	Washington	Muscatatuck River	Millport
Old Lake	Whitley	32	West shore of lake
Loon Lake	Whitley	222	South shore of lake

INDIANA STATE FISHING AREAS

Name of Area	County	Available Acres of Water	Location of Area
Greensburg Reservoir	Decatur	24	2-1/2 miles West of Greensburg
Williams Dam	Lawrence	East Fork-White River	Williams
Hindostan Falls	Martin	East Fork-White River	Between [illegible]gootee & Shoals
Grouse Ridge	Bartholomew	29	2miles SE [illegible] Ogilville
Boone's Pond	Boone	6	I-65 at St. Rd. 267
Cypress Lake	Jackson	35	I-65 and U.S. 31A Exit
White Oak	Knox	21	1-1/2 miles South of Bruceville
Scott Mill Pond	LaGrange	128	Scott
Green Valley	Vigo	26	4 miles West of St. Mary's
Elk Creek	Washington	47	9 miles NE of Salem
Martindale	Wayne	9	Near Jacksonburg & I-70
Wawasee*	Kosciusko	9	Former Fish Hatchery, Lake Wawasee-Highway 13-A
Menominee	Fulton	Tippecanoe River	1 mile North of Rochester
Brownstown	Jackson	East Fork-White River	1 mile West of Brownstown
Springs Valley	Orange	141	6 miles SE of French Lick

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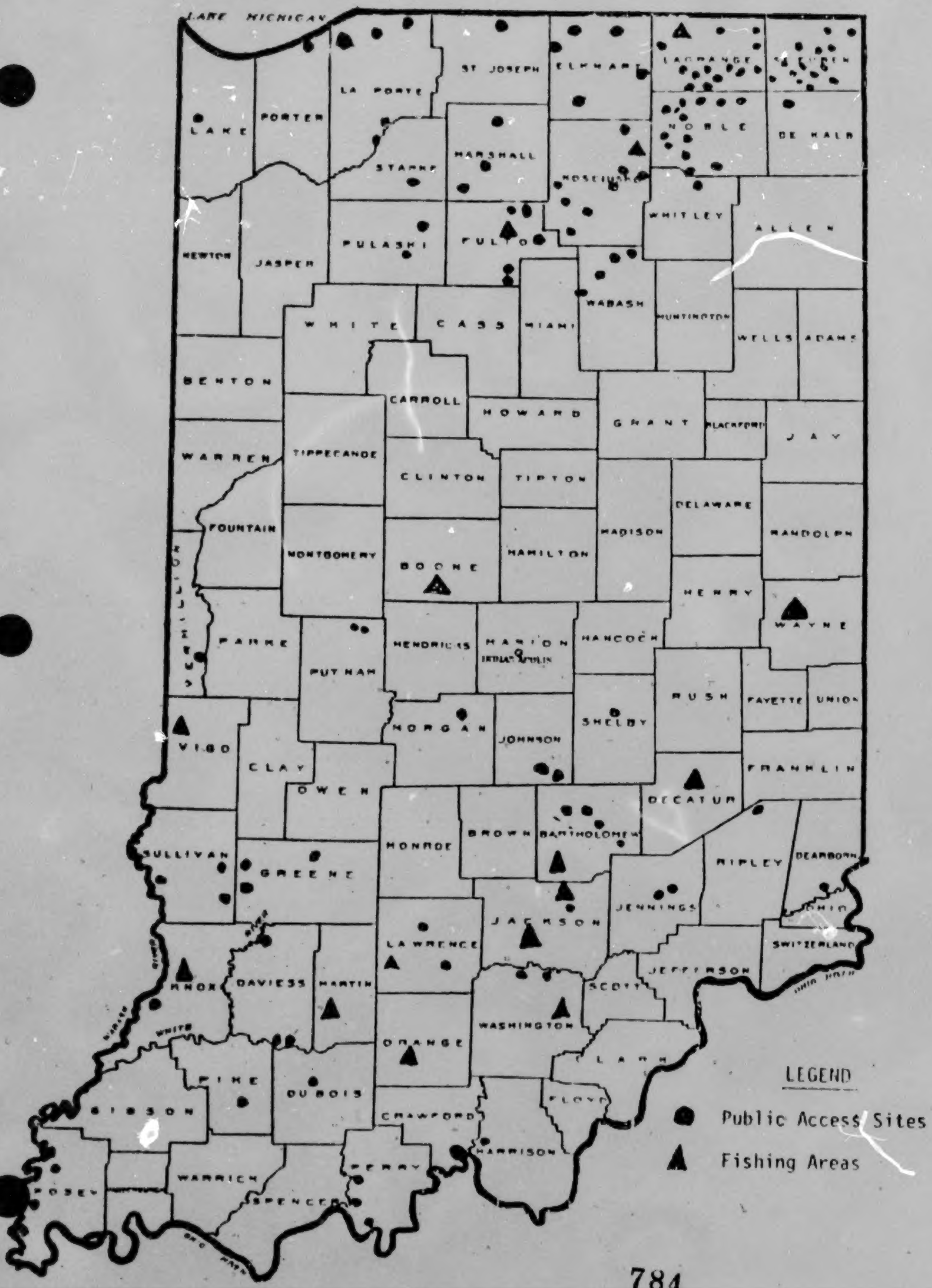
* Children under 16 yrs. of age and/or adults accompanied by children. No overnight camping facilities provided.

** Light boats and canoes only. No launching ramps.


LAKE MICHIGAN
LAKE
PORTER
LA PORTE
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ELKHART
LAGRANGE
STEUBEN
NOBLE
DE KALB
STARKE
MARSHALL
KOSCIUSKO
WHITLEY
ALLEN
NEWTON
JASPER
PULASKI
FULTON
WABASH
HUNTINGTON
WELLS
ADAMS
WHITE
CASS
MIAMI
BENTON
CARROLL
HOWARD
GRANT
BLACKFORD
JAY
WARREN
TIPPECANOE
CLINTON
TIPTON
DELAWARE
FOUNTAIN
MONTGOMERY
BOONE
HAMILTON
MADISON
RANDOLPH
VERMILLION
HENRY
PARKE
HENDRICKS
MARION
INDIANAPOLIS
HANCOCK
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OWEN
FRANKLIN
DECATUR
SULLIVAN
GREENE
MONROE
BROWN
BARTHOLOMEW
RIPLEY
DEARBORN
JENNINGS
OHIO
LAWRENCE
JACKSON
SWITZERLAND
KNOX
DAVIESS
MARTIN
JEFFERSON
SCOTT
WASHINGTON
ORANGE
CLARK
PIKE
DUBOIS
GIBSON
FLOYD
CRAWFORD
HARRISON
POSEY
WARRICK
SPENCER
PERRY
WABASH
WHITE
OHIO RIVER
LEGEND
● Public Access Sites
▲ Fishing Areas

LESSON 6: WATER

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define why water is so important.
2. Identify how water is classified and give two examples of each.
3. Define the Hydrologic cycle.
4. List five ways water is useful to us.
5. Distinguish to what extent water is on a per capita increase.
6. List who is the largest user of water today.
7. List water requirements for selected farm products.

MOTIVATION:

1. Have the class make up a list of every way they've used water today.
2. Find a free flowing clear spring in your area and take the class there to let them experience the joy of satisfying their thirst from cool, sparkling spring water.
3. Should a car be washed in water that might be watering livestock?
4. Are boating groups and irrigating farmers entitled to equal consideration of water?
5. Why has civilization clustered around or near convenient sources of fresh water?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Transparency Masters: "The Hydrologic Cycle"
"Water Demand vs. Supply"
"Water Users"
"Water Requirement Tables of Selected Farm Products"

Watershed - film, Purdue A.V. Center

Water - film, Purdue A.V. Center

Water For Farm and City - film, Purdue A.V. Center

OUTLINE:

A. Importance of Water: Next to air water is the most vital immediate necessity. 71% of our body weight is water.

B. Water Classification:

1. Surface water. This includes lakes, streams, ponds, rivers, and all forms of wetness, even ice and snow that has not yet disappeared below the ground. Surface water makes up 83% of our water.

2. Ground water. This includes water that seeps or percolates down into the earth that forms underground springs or rivers. This also includes water that seeps into porous rock, or dampness found in sub and top soils. Ground water makes up 17% of our water.

C. Hydrologic Cycle:

1. See transparency master, "The Hydrolic Cycle"

2. Definition of hydrologic cycle-Warm air masses loaded with moisture rises from the eath's surface and as it rises, it cools. Eventually moist air masses move over continents where after further cooling, it condenses and falls as rain or snow. Then, the process is repeated.

D. Five Ways Water is Useful to us:

1. Direct survival

2. Electrical power from dams

3. Irrigation

4. Transportation media - trade moves on oceans and river by ships.

5. Recreational use - boating, fishing, water skiing.

6. See the movie Watershed, 22 minutes. This is the story of a typical watershed in the state of Wisconsin, elements that make up a healthy watershed and the problems caused by poor land treatment and misuse. Location - Audio Visual Center. Shelf No. MP2410.

E. Water Supply and Demand:

1. Show transparency master "Water Demand vs. Supply."

2. We install 3 million new water faucets every year and no new water supply has been uncovered.

3. Water usage in homes without running water averages only ten gallons per day per person, while homes with running water average 60 gallons of water usage per person per day.

F. Water Consumption in 1900? 1960? 1980?

1. See transparency master "Water Users".

2. Why has there been a change? Because tecnological civilization could not have been attained at a water level consumption geared to primitive society requirements of five gallons per day. For example, one ton of steel can take up to 65,000 gallons of water to manufacture. 800 gallons of water are required to refine one barrel of oil.

3. See motion picture, Water for Farm and City.

G. Water Requirements for Selected Farm Products: (see transparency master, "Water Requirement Tables of Selected Farm Products") (See motion picture Water)

TEACHING LEARNING ACTIVITIES:

1. Have the students discuss why water is so important to us and discuss the many ways water is used. (See outline D and show the film Watershed)

2. Invite a soil conservation representative to talk with the class about watersheds and watershed protection.

3. Make up a list of ways one finds water and then classify each way. See outline B.

4. "Hydrologic cycle," what is it? How important is it? Show transparency "The Hydrolic Cycle".

5. Show film Water, 9 minutes. What happens when there is not enough water for farming and industry? Location - Purdue A.V. Center. Shelf No. MP2000 or MP2002.

6. Discuss the film Water and relate the film to increased water usage. Show the transparency master "Water Demand vs. Supply."

7. Discuss how the type of water usage and amount has changed over several years. Show the transparency masters, "Water Users" to aid in discussion.

8. Discuss how much water is required for certain farm products. Show the transparency masters, "Water Requirement Table of Selected Farm Products."

9. Show film Water for Farm and City, 13 minutes. The effect of water upon the land and its people showing areas which never have enough water--areas which have more water than they can use--those where water comes all at once, and those areas where nature helps control a year around supply. Location - Purdue A.V. Center. Shelf No.'s MP1826 or MP2403.

10. Locate the three largest users of water in the community and determine their daily water requirements.

11. Determine the average inches of rainfall in an acre area and convert it into gallons.

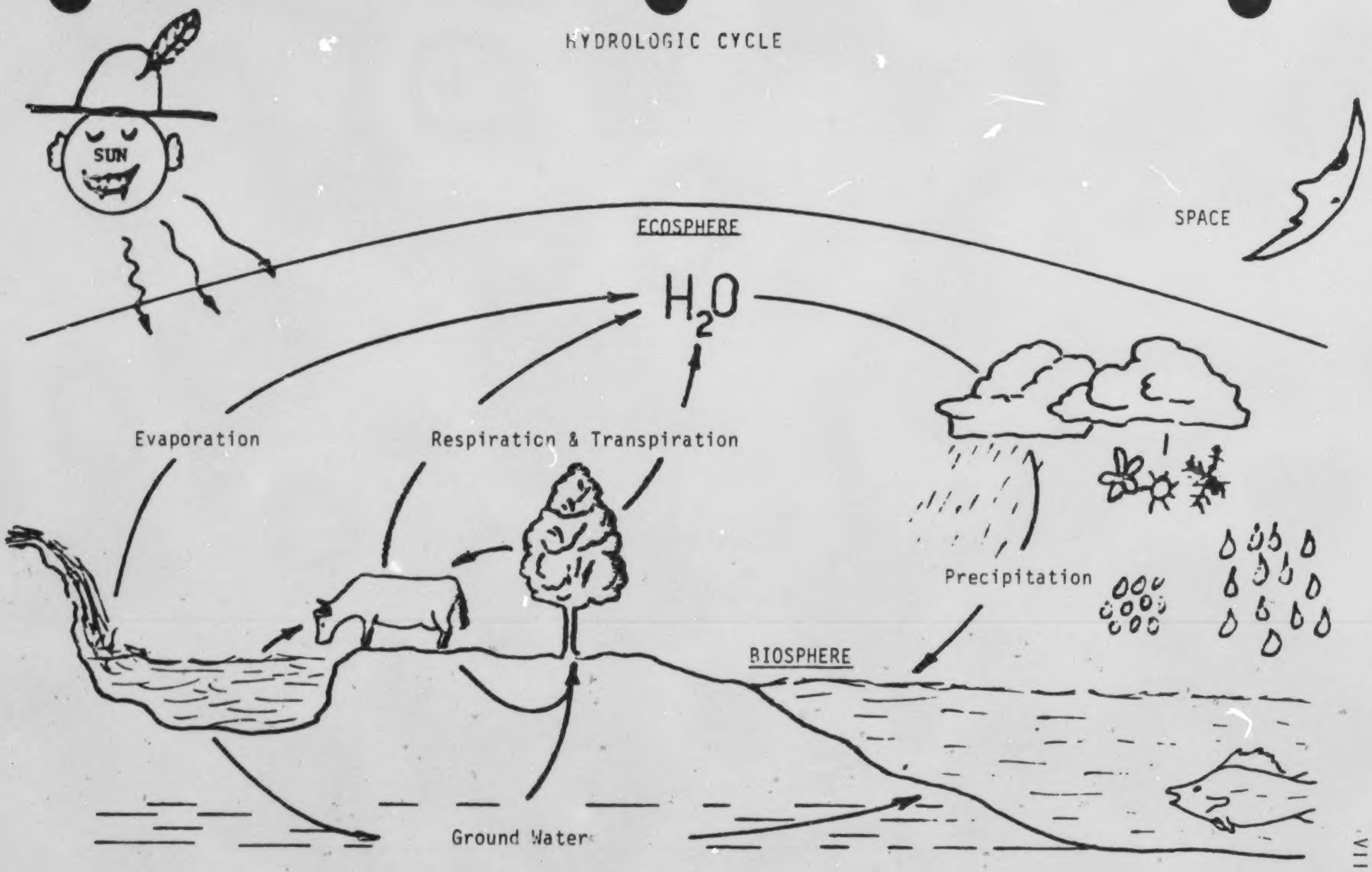
12. Set up a rain gauge and keep a daily record of rainfall at your school.

13. Locate the permanent rainfall check points in the area and determine the rainfall distribution pattern.

SUGGESTED EVALUATION:

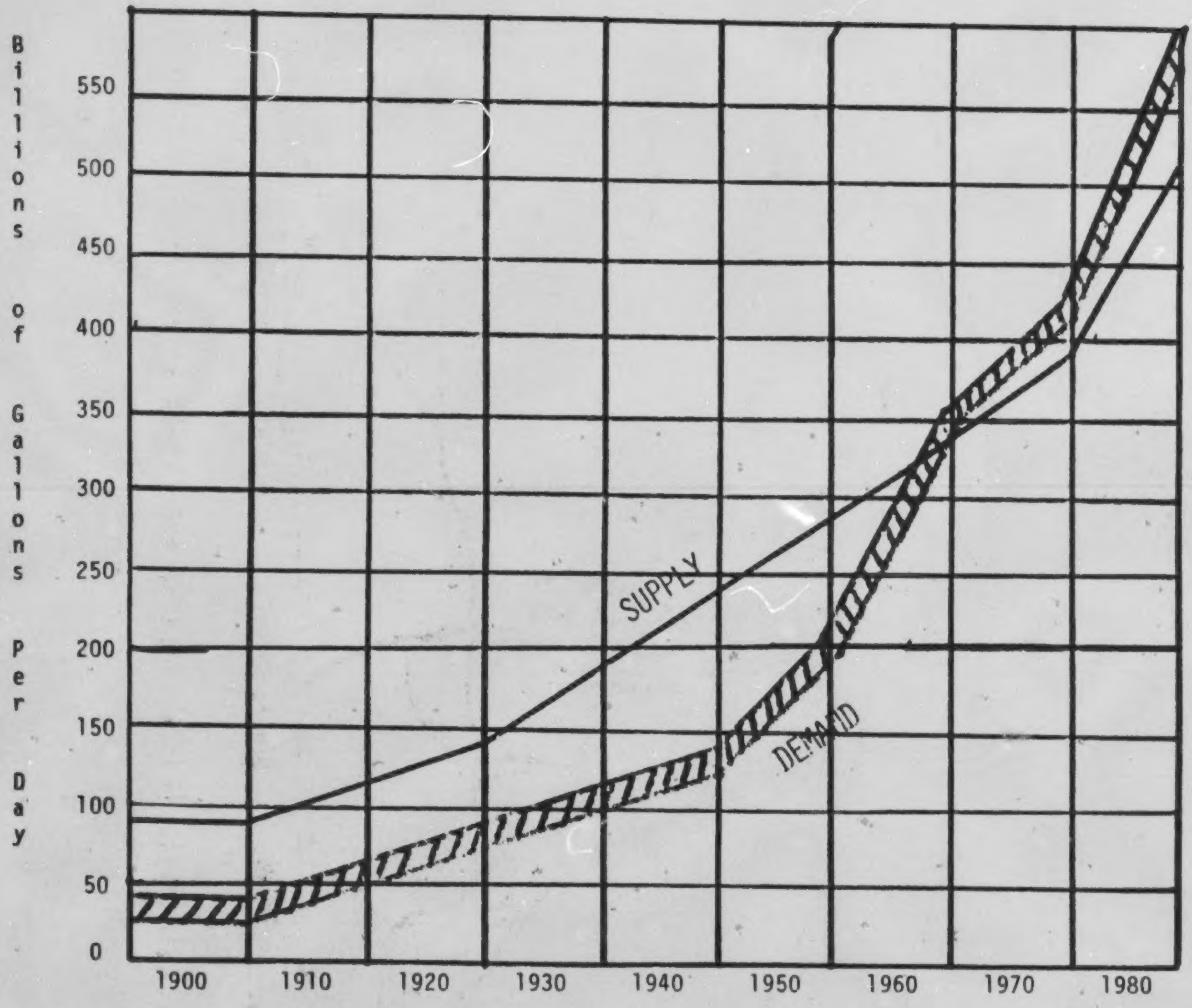
1. Give the students a written quiz over the objectives.

HYDROLOGIC CYCLE


SUN
ECOSPHERE
SPACE
H2O
Evaporation
Respiration & Transpiration
Precipitation
BIOSPHERE
Ground Water

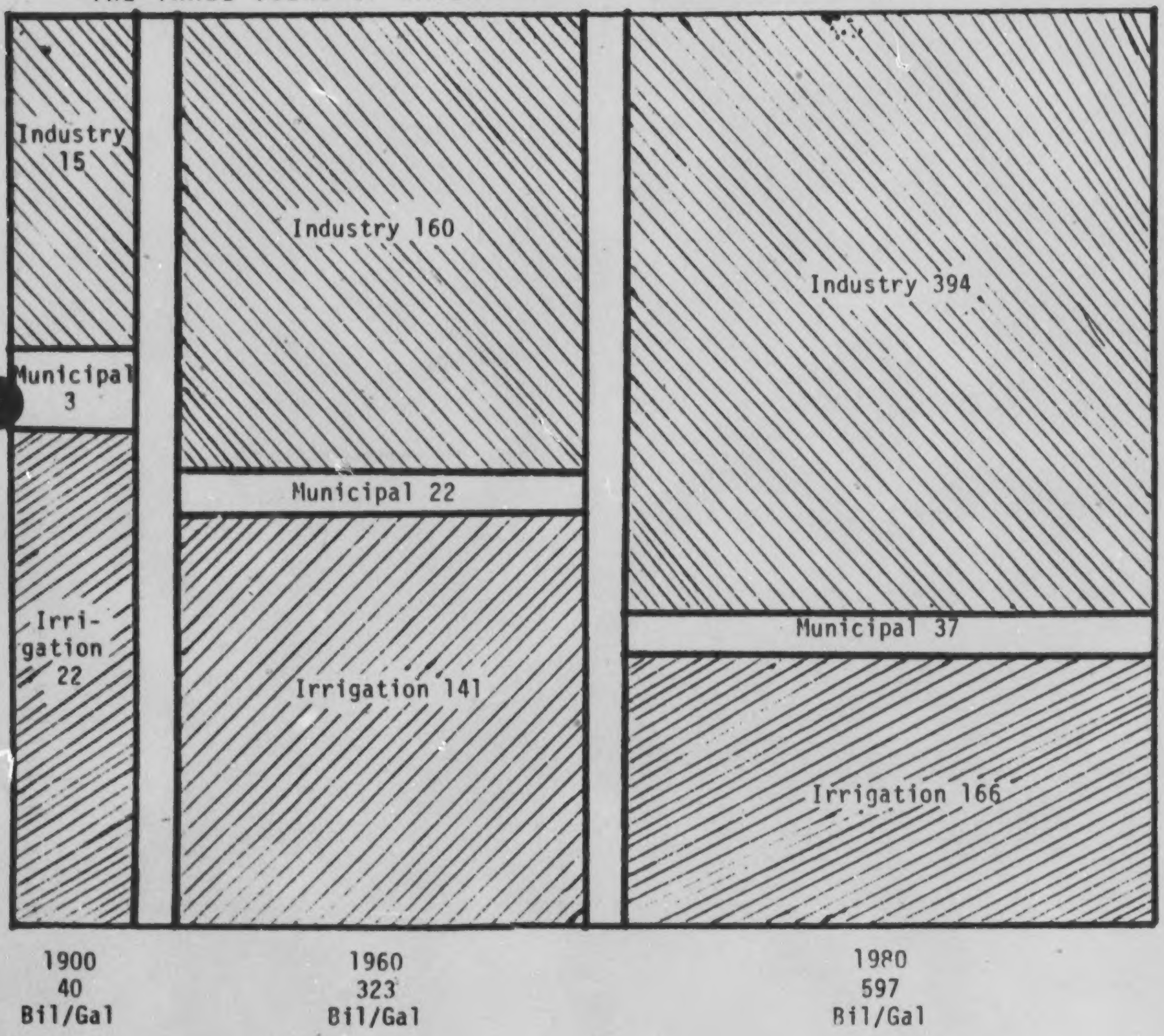
The Hydrologic Cycle is activated by the thirst of relatively dry air for moisture.

WATER DEMAND VS. SUPPLY



Courtesy of Farm Book Company

THE THREE USERS OF WATER BILLIONS OF GALLONS PER DAY



WATER USERS

Courtesy of Farm Book Company

WATER REQUIREMENT TABLE OF SELECTED FARM PRODUCTS

AMOUNT OF WATER REQUIRED	TO PRODUCE THIS MUCH	OF THIS PRODUCT
600 TONS	ONE TON	NITRATE FERTILIZER
IRRIGATION 1,000 TONS	ONE TON	SUGAR
1,500	ONE TON	WHEAT
4,000 TONS	ONE TON	RICE
10,000 TONS	ONE TON	COTTON
530 TONS	ONE TON	DRY CLOVER
23 TONS	ONE POUND	BEEF
15 TONS	ONE BUSHEL	CORN
800 POUNDS	ONE POUND	PEAS
2,500 POUNDS	ONE POUND	POTATOES

Courtesy of Farm Book Company

LESSON 7: WATER POLLUTION

OBJECTIVES:

At the completion of the lesson the student will be able to:

1. List three sources of water pollution.
2. List four kinds of water pollution.
3. List solutions to the three sources of water pollution.
4. Describe in writing the basic methods used in treating and removing municipal sewage from the water.

MOTIVATION:

1. What effect will unchecked water pollution have on man?
2. Have any of the students ever observed a polluted stream? Have them describe it.
3. Are old tires, bottles, cans, etc. water pollution? Answer: No, that's not technically water pollution--that's trash and litter.

REFERENCES:

Patterns for Preservation, National Farm Book Company.

It's Your Decision--Clean Water, film, Purdue A.V. Center

OUTLINE:

A. What Are the Three Main Sources of Water Pollution:

    1. Silt from the land - called sedimentation (silt fills up resevoirs at 1%/year).
    2. Organic wastes - sewage.
    3. Industrial wastes - toxic chemicals.

B. What Are Four Different Kinds of Water Pollution:

1. Natural pollution - leaching action of runoff water on mineral deposits, chemical treated farmland, etc.
2. Thermal pollution - hot water added to a stream or river.
3. Sewage pollution - raw or partially treated domestic waste.
4. Industrial wastes - chemicals, sludge, debris.

C. Solutions to the Three Main Sources of Water Pollution:

1. Sedimentation - since silt fills up reservoirs at 1% per year, silt must be kept out of the water. This can be done by good land management on the slopes which feed the water into streams or rivers.
2. Sewage -there are two kinds of sewage treatment, primary and secondary.
    a. Primary treatment of sewage water removes 35% of the pollution and involves screening the polluted water to catch large objects, then allowing it to settle. The solids in the waste matter settle to the bottom as "sludge" or rise to the top as "scum". The water between these two layers is then drained off. If water still needs treatment after primary treatment, more expensive steps are taken in ...
    b. Secondary treatment of sewage. This involves letting bacteria remove dissolved organic matter from the water as it trickle filters over a bed of gravel. Finally, clorine may be added as a safeguard as this treatment removes 85% of pollution load.
3. Industrial wastes - federal laws now requires manufacturers to meet minimum pollution requirements.

TEACHING AND LEARNING ACTIVITIES:

1. Have the students cut out newspaper clippings and pictures for a bulletin-board that deals with water pollution and its effects.
2. Use clippings in discussion of causes and methods of control and prevention of water pollution.
3. Visit a local sewage treatment plant and have its operator give the class a tour.
4. View polluted water under a microscope and compare it with tap water. Note the impurities found in polluted water.

4. Although tires, bottles, cans, etc. aren't water pollution, take the class out to a local stream and pick up trash (a pollution to the eye).

5. Discuss why we have sewage treatment plants, septic tanks, etc. Show the movie It's Your Decision--Clean Water, located in the Purdue A.V. Center. Shelf No.'s MP2729 or MP2728. The film discusses how secondary sewage treatment will help provide adequate supplies of clean water for recreation and industry.

6. Use a water pollution detection kit and determine alkalinity, ammonia, calcium, carbon dioxide, chloride, chlorine, chromium, copper, cyanide, dissolved solids, iron, magnesium, nitrates, phosphate, salinity, and sulfide content of water samples collected in the community.

7. Take a field trip to a watershed and locate possible pollution sources in the area. Collect samples from these sources and analyze them.

8. Take a field trip to a water testing laboratory.

9. Have a public health doctor speak on the importance of potable water to individual health.

EVALUATION:

1. Give the students a quiz over the objectives.

LESSON 8: HISTORY AND IMPORTANCE OF FORESTS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define who and when was the first white man to see the forests of Indiana.
2. Tell what precent of Indiana was originally covered with timber, and what percent of Indiana is forested today.
3. Define why early forests in Indiana were both a blessing and a burden.
4. List five facts about forests.
5. Define five values of forests.
6. Name ten important Indiana woods, their properties, and uses.

MOTIVATION:

1. Have the students comment on the following quote, written over a century ago by Henry Thoreau:

   "If a man walks in the woods for love of them half of each day, he is in danger of being regarded as a loafer; but if he spends his whole day as a specular, shearing off those woods and making earth bald before her time, he is esteemed as an industrious and enterprising citizen. As if society had no interests in its forests but to cut them down."

2. Make up a list of forest products found in your classroom.

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handouts: "The Forests of Indiana", F-34, Purdue University Cooperative Extension Service
"Some Important Indiana Woods, Their Properties and Uses", F-27 Cooperative Extension Service, Purdue University
"Forestry and Wildlife As a Career", F-53, Purdue University Cooperative Extension Service
"Forests and Our Environment", F-63, Purdue University, Cooperative Extension Service

The Forest, Film - Purdue A.V. Center, 28 minutes.
The multiple use benefits to be obtained from our national forests. How water is conserved, how timber grows, is harvested, and replenished. How range and wildlife flourishes and how mankind may enjoy the natural beauty and healthful recreation available. Shelf No. MP0322 or MP1147.

Wilderness Trail - Film - Purdue A.V. Center, 15 minutes.
A trip through the Bridger Wilderness in Wyoming. A rugged area in the Rockey Mountains, which has remained virtually unchanged for centuries. Shelf No. MP2071.

Transparency Masters: "Partial List of Products From Trees"
"Livestock in Woods"
"Injun Summer"

OUTLINE:

A. Who Was the First White Man to See Indiana Forests:

1. Answer: History records that in 1669, LaSalle was the first white man to see Indiana. (See F-34).

B. How Much of Indiana was Originally Forested? Today?

1. Answer: 87 1/2 percent originally was forested, only 17percent is forested today.

C. How Were Early Indiana Forests Both a Blessing and a Burden? (See F-34).

1. Answer: They were a blessing in that they provided shelter, fuel furniture, rail for fences, lumber for boats, barrels, etc.

2. Answer: They were a burden in that timber was on good land, in the way of agriculture, clearing it for crops was a strenuous, burdensome task.

D. Facts Worth Noting About Forests:

1. Only 50% of the original forested areas remain in the U.S. today.

2. No crop demands as much of the soil as a tree.

3. If properly used, 80% of a harvested tree will go into commercially useful products.

4. It takes 40 acres of good pulp timber to produce one complete circulation of an average Sunday paper.

5. Timber goes into 5,000 different products valued at 23 billion dollars. (See,"Partial List of Products From Trees")

6. Grazing livestock in forests ruin them by soil compaction from the animals. (See,"Livestock in Woods")

7. Note worth remembering: In forestry, tomorrow is too late. The timber we would have in the future must be growing now.

8. During 1941-1945, armed forces used a greater tonage of wood than steel to help in the war effort.

E. Five Values of Forests:

1. Forest products (See,"Partial List of Products From Trees")

2. Water shed to prevent erosion (show film, The Forest)

3. Wildlife habitat (Show film, Wilderness Trail)

4. Esthetic Values (See,"Injun Summer")

5. Jobs for people

F. Some Important Indiana Woods, Their Properties and Uses:

1. See F-27. The instructor will decide which and how many of the listed woods he will expect his students to learn.

TEACHING LEARNING ACTIVITIES:

1. Have the students speculate what Indiana was like in 1669 when LaSalle first saw it.

2. Have students make a list of common wood products and determine what type of wood they are made from. Use handout F-27.

3. Show the film The Forest and discuss the specific details of the film.

4. Ask the students what are some values of forests.

5. Take a field trip to a saw mill or furniture factory and view the types of wood used and how wood is used.

6. Have students make a list of Indiana wood types, their properties, and uses.

7. Review the careers related to forestry. See handout F-53.

8. Discuss and list ways man is dependent on products and services available from forests.

SUGGESTED EVALUATION:

1. Assign grades to class activities and field trip reports.

2. Quiz students on class discussion materials.

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forestry &
natural
WOODLAND MANAGEMENT resources

THE FORESTS OF INDIANA

by W. L. Fix, Extension Forester

History records that in 1669, LaSalle was the first white man to see Indiana.

Ten years later, he came down the St. Joseph River in Indiana, crossed over near South Bend to the Kankakee River and then went south via the Illinois River and the Mississippi. On his first voyage, LaSalle described the area along the Wabash as being heavily wooded, while that adjacent to the Kankakee, he wrote, was partly grassland.

The exact acreage of the original Indiana woodlands is not known. Stanley Coulter, one of the early conservationists of the state, reported in 1899, "Originally, seven-eights (87½ percent) of the 23,000,000 acres comprising the area of the state was covered with a dense growth of timber...With the exception of Benton county and parts of other counties in the northwestern section of the state, Indiana for the most part was covered with one of the finest stands of hardwoods in America."

The Early Forests

The early forests were both a blessing and a burden. As a blessing, they provided shelter, fuel and furniture. They supplied rails for fences, planks for roads, lumber for boats, and rafts, barrels and casks, and even machinery parts, as the wooden wheels of an old grist mill at Spring Mill State Park so eloquently testify.

Standing timber, on good land, was in the way of agriculture. Clearing it for cropping was a strenuous, burdensome task. Strangely enough, few settlers would buy prairie land if it did not include some woodland. In letters written by Jacob Schramm, who settled in Indiana in 1836, he stated, "If the prairie is too big, however, and has no woods near, it is not habitable and is not purchased even if the soil is the finest.

The vastness of the original hardwood forests and the persistance of natural sprouting when these were cut, led early settlers into thinking that good timber sufficient for all needs would always be at hand. Long ago we found that this was not true.

The Forests Today

Today in Indiana there are about 4 million acres of forest land. As the map shows, about 24 percent of this is in the northern part of the state. The remainder, or 76 percent, is divided among three major geological areas of southern Indiana. The lower Wabash unit contains 21 percent, the Knobs unit 46 percent and the Upland Flats unit 9 percent of the state total.

Indiana forests are owned by many people. Farmers own the largest amount of timber land. Altogether they own more than 2,661,000 acres, or 68 percent of all timber land. A little more than 22 percent of the forest land is owned by coal companies, water companies, sawmill companies, estates, and other private owners. Public agencies, including cities, counties, the state and federal government, own the remaining 10 percent of land in forests.

Thus we see that today, 90 percent of all the forest land in Indiana is privately owned.

The important and valuable hardwood tree species are white and red oaks, walnut, cherry, tulip poplar, sugar maple, ash, hickory and basswood. Tulip poplar, or tuliptree, is the State tree. Native evergreen species have not been common in Indiana since the glaciers receded several thousand years ago. However, natural growth of white and jack pine is found in limited areas of Northern Indiana counties. Hemlock occurs in a few places along

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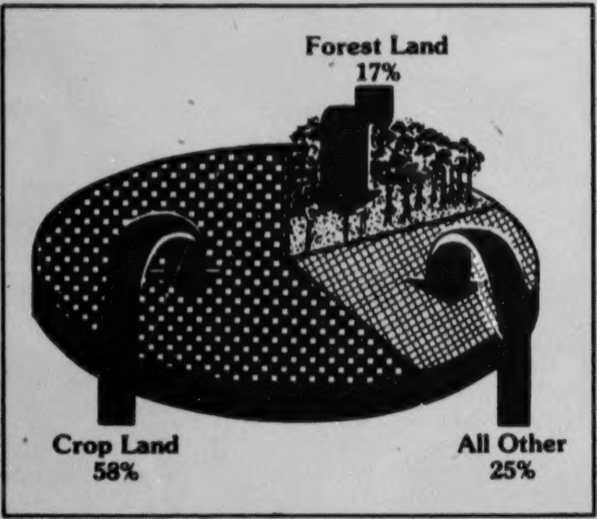
watercourses. In southern Indiana, Virginia pine occurs in the hilly knobs unit near the Ohio River. Red cedar is also common in many counties. For many years the coniferous (evergreen) trees have been widely planted all over Indiana to rebuild worn-out soils, prevent erosion, serve as wind-breaks and for various other special purposes, such as Christmas trees. Indiana's total land area is an estimated 23.1 million acres. Of this area, forests occupy 17 percent, or nearly 4 million acres.

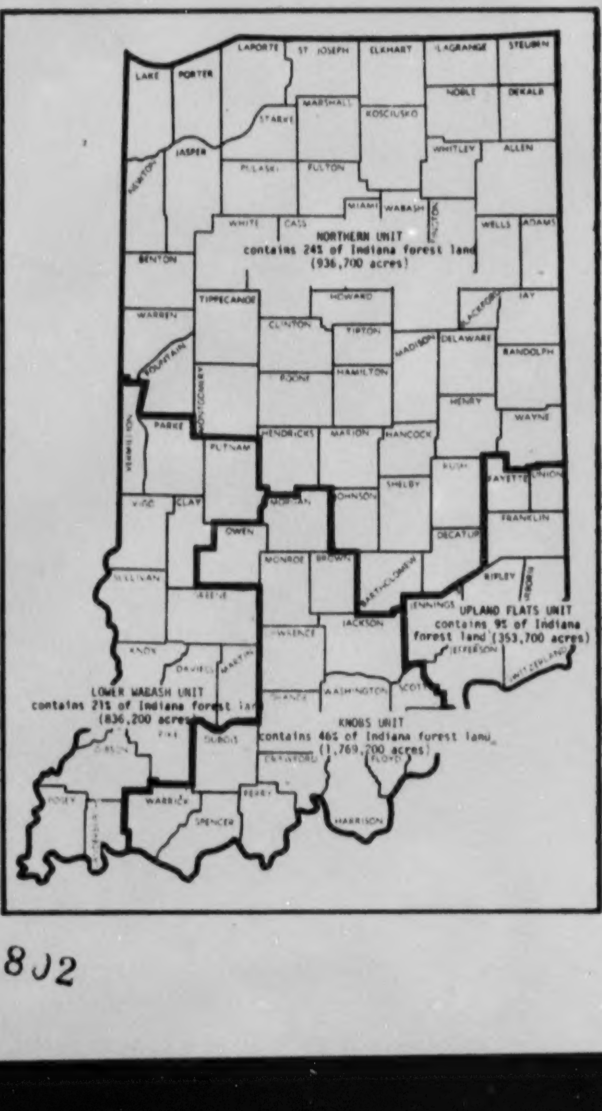


Forest Products

High-quality hardwoods once grew in Indiana, and they can do so again. For many years, our timber has sold for premium prices for many highly important and special products. Because of this quality and abundance, many wood-using industries are located in the State. Today, Indiana is one of the leading producers of furniture and hardwood veneer, though much of the lumber comes from other states.

From the sale of standing timber, logs, bolts, posts, pulpwood and other products, woodland owners receive annually about $27 million. Much of this material goes to wood-using industries, where it is processed by more than 40,000 workers, whose salaries and wages exceed $247 million. In economic terms—salaries, wages, power, machinery, interest, and profit—the manufacture of forest products contributes heavily to the State's economy. Our forests are one of our important natural resources. They are renewable and will continue to yield wealth to our farmers, to labor, and to industries year after year, if they are properly managed.

Adequate protection and sound management could increase both the quality and quantity of woodlands. The quantity of products harvested could be more than doubled, and this could mean more wealth-producing industries. Better woodlands could supply additional areas for recreation, aid water conservation, furnish wildlife habitats and reduce weather extremes.


NORTHERN UNIT
contains 24% of Indiana forest land
(936,700 acres)
UPLAND FLATS UNIT
contains 9% of Indiana
forest land (353,700 acres)
LOWER WABASH UNIT
contains 21% of Indiana forest land
(836,200 acres)
KNOBS UNIT
contains 46% of Indiana forest land
(1,769,200 acres)
LAKE
PORTER
LAPORTE
ST JOSEPH
ELKHART
LAGRANGE
STEUBEN
NOBLE
DEKALB
STARKE
MARSHALL
KOSCIUSKO
WHITLEY
ALLEN
NEWTON
JASPER
PULASKI
FULTON
MIAMI
WABASH
HUNTINGTON
WELLS
ADAMS
WHITE
CASS
BENTON
TIPPECANOE
HOWARD
BLACKFORD
JAY
WARREN
CLINTON
TIPTON
MADISON
DELAWARE
RANDOLPH
FOUNTAIN
MONTGOMERY
BOONE
HAMILTON
HENRY
VERMILLION
PARKE
HENDRICKS
MARION
HANCOCK
WAYNE
PUTNAM
RUSH
FAYETTE
UNION
VIGO
CLAY
MORGAN
JOHNSON
SHELBY
FRANKLIN
OWEN
DECATUR
MONROE
BROWN
BARTHOLOMEW
RIPLEY
DEARBORN
SULLIVAN
GREENE
JENNINGS
LAWRENCE
JACKSON
JEFFERSON
OHIO
SWITZERLAND
KNOX
DAVIESS
MARTIN
ORANGE
WASHINGTON
SCOTT
CLARK
GIBSON
PIKE
DUBOIS
CRAWFORD
FLOYD
POSEY
VANDERBURGH
WARRICK
SPENCER
PERRY
HARRISON

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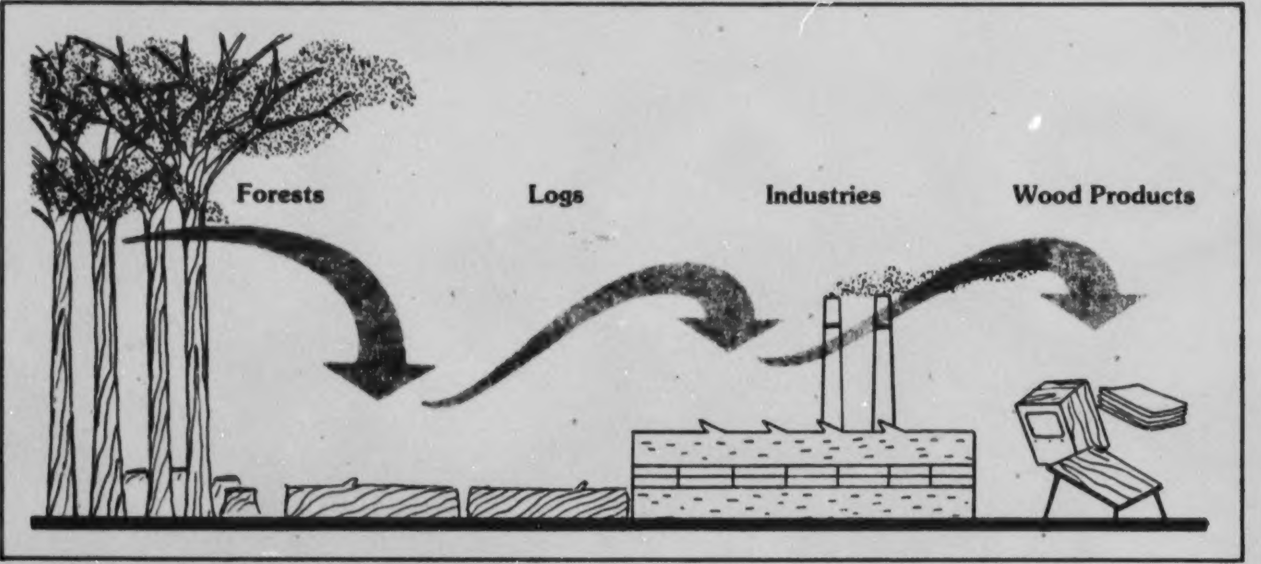
Forest Management

More timber, and better quality timber, can be grown in Indiana if proper care is given our woodlands. To practice good forestry, the following steps should be taken:

1. Plan the land according to its best use.
2. Take livestock out of the woods.
3. Keep all fire out of the woods.
4. Get more trees growing on every acre that is best suited for woodland.
5. Encourage the species and quality of trees needed for wood products.
6. Plant pines on "worn-out" or "farmed-out" land as a nurse crop to restore the hardwood forests of Indiana. The pines are useful also for erosion control, wildlife habitat, windbreaks and Christmas trees.

Further information or additional copies of this publication can be obtained through your county Extension agent, nearest forester, or the Department of Forestry and Natural Resources at Purdue University, West Lafayette, Indiana.



Timber sold by woodland owners is valued at $27 million. The value added by manufacturing in both the primary and secondary industries exceeds $600 million. (This includes the value of imported timber.) Salaries and wages of wood-workers exceed $300 million a year. (Bureau of Census, 1974).

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forestry & natural resources
MARKETING AND UTILIZATION

SOME IMPORTANT INDIANA HARDWOODS THEIR CHARACTERISTICS AND USES

Daniel L. Cassens
Extension Forest Products Specialist

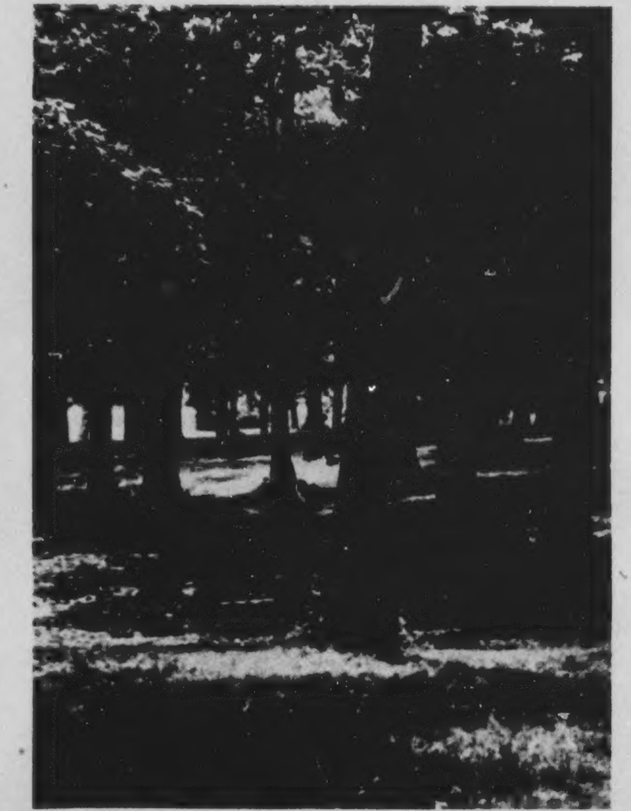
The broad-leaved deciduous trees of Indiana, collectively referred to as hardwoods, are known the world over for their excellent quality. They are famous for many special products such as furniture, face veneers, handles, crates and pallets, barrels, and an infinite variety of everyday items.

Several evergreen or softwood species such as white pine, jack pine, Virginia pine, larch, hemlock, cypress, eastern arborvitae, and eastern red cedar are also native to Indiana. With the exception of eastern red cedar, most of these trees occur sporadically or in very small isolated stands and are not of commercial importance. Red cedar, however, is common and can be found throughout Indiana. Some of the pines have been used for reforestation projects and for horticultural purposes.

Physical and mechanical properties of wood such as color, weight, hardness, and type of grain determine the use of the various tree species. Because of the beautiful color and characteristic grain figure of their wood, high quality logs of red and white oak and black walnut are widely sought after, both in this country and for export. Lower quality material of the oaks may be converted into crossties, pallets and other rough products. Woods such as elm and beech, which bend easily when steamed and hold their shape when dried, are commonly used for furniture parts which require bending. Very hard and heavy woods such as hickory, dogwood and beech are good for fuel.

Most tree cross sections of hardwoods show a conspicuous dark central core surrounded by a light colored outer band. The dark core is called heartwood and the light band sapwood. The heartwood of some trees, such as osage orange and eastern red cedar, is naturally durable or resistant against decay and insects. Heartwood from these trees makes good fence posts, while the sapwood of all species is nonresistant to decay and insect attack. Heartwood can be classified as durable, moderately durable, or non-durable. Since durability within a species can also be affected by other factors, it is generally best to use wood pressure treated with a wood preservative if high resistance to decay or insects is required.

The following pages will provide further information concerning the characteristics and uses of many Indiana species. It is not exhaustive, but will illustrate some properties and common uses.



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SPECIES	CHARACTERISTICS[1,2]	USES
Ash	Grayish brown, light brown, or pale yellow streaked with brown, straight and open grained, odorless and tasteless, hard and heavy, high shock resistance and good bending qualities, non-durable.	Handles, furniture, kitchen cabinets, athletic equipment, face veneer.
Aspen	Whitish, creamy to light grayish brown, straight and close grained, tasteless and odorless when dry, disagreeable odor when wet, soft and light, non-durable.	Pulpwood, matches, pallets and crates, particleboard, corestock for plywood.
Basswood	Pale brown, sometimes with a reddish tinge, straight and close grained, characteristic odor on fresh-cut surface, tasteless, soft and light, non-durable.	Concealed furniture parts, food containers, corestock for plywood, millwork.
Beech	Whitish with a reddish tinge to reddish brown, straight to interlocked grain, close grained, odorless and tasteless, hard and heavy, good bending qualities, non-durable.	Concealed furniture parts, woodenware and novelties, toys, crossties, handles, crates and pallets.
Birch, River	Light to dark brown or reddish brown, straight and close grained, odorless and tasteless, hard and heavy, non-durable.	Pulpwood, crossties, kitchen cabinets, crates and pallets.
Buckeye	Creamy white to pale yellowish white, straight and close grained, sometimes with mild characteristic odor, tasteless, light and soft.	Pallets and crates, novelties, drawing boards.
Catalpa	Grayish brown, occasionally with a lavender tinge, straight and open grained, faint aromatic noncharacteristic odor, tasteless, moderately light and soft, durable.	Fence posts, local cabinetry.
Cherry	Light to dark reddish brown, straight and close grained, odorless and tasteless, moderately heavy and hard, non-durable.	Furniture, face veneer, cabinetry, interior trim, paneling, piano actions, woodenware and novelties.
Coffee Tree	Light red to red or reddish brown, straight and open grained, odorless and tasteless, hard and heavy.	Local cabinetry, crossties, crates and pallets.
Cottonwood	Grayish white to light grayish brown, straight and close grained, odorless when dry, characteristic disagreeable odor when wet, tasteless, light and soft, non-durable.	Pulpwood, corestock in plywood, food containers, concealed furniture parts, crates and pallets.

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SPECIES	CHARACTERISTICS[1,2]	USES
Dogwood	Sapwood light pinkish brown, very wide; heartwood dark brown, frequently variegated, straight and close grained, odorless and tasteless, very hard and heavy.	Shuttles for textile weaving, bobbin heads, golf club heads, jewelers blocks, mallet heads.
Elm, American (White Elm)	Light brown to brown, frequently with a reddish tinge, straight or sometimes interlocked grain, open grained. Generally without characteristic odor or taste, moderately hard and heavy, good bending qualities, non-durable.	Furniture, face veneer, paneling, fruit and food containers, crates and pallets.
Elm, Slippery (Red Elm)	Brown to dark brown, frequently with shades of red, sometimes with interlocked grain, open grained, odorless and tasteless, moderately hard and heavy, good bending qualities, non-durable.	Same as American Elm.
Blackgum	Sapwood white to grayish white, very wide; heartwood greenish to brownish gray, interlocked and close grained, odorless and tasteless, moderately hard and heavy, non-durable.	Pulpwood, concealed furniture parts, fruit and food containers, crates and pallets, crossties.
Sweetgum (Red Gum)	Reddish gray to varying shades of reddish brown, the darker grades frequently with darker streaks of pigment figure (called figured redgum in the trade), interlocked and close grained, odorless and tasteless, moderately hard and heavy, non-durable.	Furniture, kitchen cabinets, plywood, pulpwood, fruit baskets, crossties, crates and pallets.
Hackberry	Heartwood yellowish gray to light brown streaked with yellow, straight or sometimes interlocked grain, open grained, odorless and tasteless, moderately hard and heavy, non-durable.	Furniture, millwork, fruit baskets, crates and pallets.
Hickory	Pale brown to brown or reddish brown, straight and open grained, odorless and tasteless, hard and heavy, non-durable.	Furniture, tool handles, ladder rounds, sporting goods, woodenware and novelties.
Locust, Black	Greenish yellow to dark yellowish, greenish, or golden brown, straight and open grained, odorless and tasteless, hard and heavy, durable.	Fence posts and poles, insulator pins, crossties, crates and pallets, woodenware and novelties.
Locust, Honey	Light red to reddish brown, straight and open grained, odorless and tasteless, hard and heavy, moderately durable.	Local construction and local cabinetry.

SPECIES	CHARACTERISTICS[1,2]	USES
Maple, Hard	Light reddish brown, straight grained but occasionally curly, wavy or birds eye, close grained, odorless and tasteless, hard and heavy, non-durable.	Furniture, factory, gymnasium and home flooring, bowling alley floors and pins, musical instruments, sporting and athletic equipment, crossties, pulpwood, crates and pallets.
Maple, Soft	Light brown sometimes with a grayish or greenish tinge or with a faint, purplish cast, straight and close grained, odorless and tasteless, moderately hard and heavy, non-durable.	Furniture, food containers, crates and pallets, pulpwood.
Mulberry	Orange yellow to golden brown, turning rustic brown on exposure, straight and close grained, odorless and tasteless, hard and heavy, durable.	Fence posts, local cabinetry.
White Oak Group	Light brown to dark brown, straight and open grained, odorless and tasteless, very hard and heavy, durable.	Furniture, kitchen cabinets, face veneer, flooring, posts, whisky barrels, crates and pallets, millwork, paneling, crossties, heavy timbers.
Red Oak Group	Pinkish to light reddish brown, straight and open grained, generally odorless and tasteless, bacterially infected oak with rancid odor, very hard and heavy, non-durable.	Same as white oak except not suitable for whisky barrels or other "tight cooperage" and is not decay resistant.
Osage Orange	Golden yellow to bright orange, darkening upon exposure, often with reddish streaks along the grain, straight and close grained, odorless and tasteless, very hard and heavy, durable.	Posts, insulator pins, archery bows, previously used as dyewood (yellow, green, brown).
Persimmon	Heartwood usually very small, blackish brown to black, often streaked irregular in outline, straight and fairly close grained, odorless and tasteless, very hard and heavy.	Golf club heads, shuttles, bobbins, small tool handles.
Sassafras	Dull grayish brown to orange-brown or dark brown, straight and open grained, odor of sassafras, moderately hard and heavy, durable.	Locally for furniture and paneling, fence posts, millwork.
Sycamore	Light to dark brown or reddish brown, irregularly interlocked and close grained, odorless and tasteless, moderately hard and heavy, non-durable.	Concealed furniture parts, millwork, paneling, fruit containers, crates and pallets, pulpwood.

SPECIES	**CHARACTERISTICS[1,2]**	**USES**
Tuliptree (Yellow Poplar)	Variable in color, ranging from yellow to tan or brown, frequently marked with shades of purple, dark green, blue or black, straight and close grained, odorless and tasteless moderately light and soft, non-durable.	Furniture, millwork, corestock for plywood, face veneer, fruit containers, crates and pallets.
Walnut, Black	Light brown to rich chocolate or purplish brown, straight and somewhat open grained, mild characteristic odor when worked, tasteless, heavy and hard, stable when dry, durable.	Furniture, face veneer, paneling, gun stocks, interior trim and paneling, woodenware and novelties.
Walnut, White (Butternut)	Light chestnut brown, frequently variegated with pigment figure, straight and somewhat open grained, odorless and tasteless, moderately light and soft.	Furniture, face veneer, paneling, interior trim, novelties.
Willow	Light brown to pale reddish or grayish brown, frequently with darker streaks along the grain, straight and close grained, odorless and tasteless, moderately light and soft, non-durable.	Concealed furniture parts, corestock for plywood, caskets, crates and pallets, woodenware and novelties.
Eastern Red Cedar	Purplish or rose red when first exposed, aging to dull red or reddish brown sometimes with light streaks, straight and close grained, characteristic cedar odor and taste, moderately heavy and hard, durable.	Posts, woodenware and novelties, wardrobe and closet linings, "aromatic" particle board.

[1] Except as noted, color refers to heartwood or the darker central core of the tree. Sapwood is generally light colored and not characteristic.

[2] Open grain refers to those woods with large pores and thus a somewhat uneven surface, as in oak. Close grained refers to woods with small pores and thus a smooth surface, as in maple. In diameter, pores are the largest cells in hardwoods. In open grained woods they appear as tiny openings on a smooth end grained surface or as long narrow slits on a longitudinal surface.

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Notes on Forestry and Wood-use

Purdue University
Cooperative Extension Service
W. Lafayette, Indiana 47907

F-53
May 1974

FORESTRY AND WILDLIFE AS A CAREER

A Selected List of Publications

Compiled by H. C. Krauch, Jr., Extension Wildlife Specialist

Increased numbers of high schools are participating in career guidance days or similar guidance programs. It has been noted on numerous occasions that little is known of prerequisite educational requirements for forestry and wildlife careers at both the professional and technician level.

The objective of this publication is to provide sources of information to assist guidance personnel and students in finding out more about these two fields at both levels.

Usually single copies are free and may be obtained by writing to the source as given; some are nominally priced.

FORESTRY CAREER PUBLICATIONS

From:
Society of American Foresters
1010 Sixteenth Street, N. W.
Washington, D. C. 20036 .

Ask Any Forester
Forestry as a Profession

From:
American Forestry Association
1319 Eighteenth Street, N.W.
Washington, D. C. 20036

So You Want to be a Forester?
What Do Employers Want?

From:
Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Careers in Forestry, M-249
Forestry Schools in the United States, FS-9
Opportunity in Forest Service Management Careers, PA-535
Engineers in the Forest Service, M-1089
Move Ahead -- Research Careers in The Forest Service, M-1109
A Job With the Forest Service -- A Guide to Nonprofessional Employment, M-843
A Summer Job With the U. S. Forest Service, O-29
Women in the Forest Service, M-1058
The Landscape Architect: A Career in the Forest Service
You Can Be a Conservationist
Career Profiles in: Forestry, Conservation, Ecology and Environmental Management, FS-308

From:
New York Life Insurance Company
51 Madison Avenue
New York, NY 10010

Should You Be A Forester?

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

From:
Forest Products Laboratory
Forest Service, USDA
North Walnut Street
Madison, WI 53705

Your Career in Forest Products Research, Report 2186

From:
National Forest Products Association
Technical Education Department
1619 Massachusetts Avenue, N. W.
Washington, D. C. 20036

Opportunities Unlimited in the Forest Products Industries
The Challenge of the Forest -- Youth Looks to the Future in Wood
Colleges and Universities (with forest products curricula). A list.

From:
Chronicle Guidance Publications, Inc.
Monrovia, NY 13118

Forest Conservation Occupations
Forestry Aide

Note: Forest Technician Training (less than a 4-year program)

A listing of 51 institutions offering 1 or 2-year courses in forest technician training is available from the Extension forestry office, Department of Forestry and Conservation, Purdue. It should be emphasized that none of the training programs at any of the listed institutions have been evaluated, and the list is presented for information only.

WILDLIFE CAREER PUBLICATIONS

From:
The Wildlife Society
3900 Wisconsin Avenue, N. W.
Washington, D. C. 20016

A Career for You in Wildlife Conservation
Universities and Colleges with Wildlife Management and Conservation Curricula in North America
Training and Employment of Wildlife Biologists and Fisheries Biologists

From:
American Fisheries Society
Suite 504-7
1404 New York Avenue, N. W.
Washington, D. C. 20005

Fisheries as a Profession (a career guide for the fishery science)

From:
Conservation Department
Olin Mathieson Chemical Corporation
East Alton, IL 62024

Careers in Wildlife Conservation

From:
Sport Fishing Institute
608 Thirteenth Street, N. W.
Washington, D. C. 20005

Institutions and Professors Offering Fishery Biology and Related Courses in U. S. Colleges and Universities

From:
Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Employment Opportunities in the Bureau of Sport Fisheries and Wildlife

From:
Bureau of Sport Fisheries and Wildlife
U. S. Department of Interior (Interior Bldg.)
Washington, D. C. 20240

Preparation for a Career in Fish Conservation
Preparation for a Career in Wildlife Conservation
Careers: U. S. Game Management Agent-Pilot

From:
Division of Fish and Wildlife
607 State Office Building
Indianapolis, IN 46204

Planning a Career in Fish and Wildlife Management

BOOKS

Careers in Conservation, edited by
Henry Clepper
The Ronald Press Company
15 East 26th Street
New York, NY 10010

Forestry and Its Career Opportunities
Hardy L. Shirley
McGraw-Hill Book Company
330 West 42nd Street
New York, NY 10035

Careers in Natural Resource Conservation
Fred W. Herbert
Henry C. Walck, Incorporated
19 Union Square West
New York, NY 10003

Conservation Careers
Soil Conservation Society of America
7515 N. E. Ankeny Road
Ankeny, IA 50021

Wildlife Law Enforcement
William F. Sigler
William C. Brown Company
Dubuque, IA

MISCELLANEOUS

From:
U. S. Civil Service Commission
Washington, D. C. 20415

Summer Jobs in Federal Agencies
Federal Jobs Overseas

From:
Crowell-Collier Press
866 Third Avenue
New York, NY 10022

Careers for the 70's -- Conservation

From:
U. S. Department of Labor
Wage and Labor Standards Administration
Women's Bureau
Washington, D. C. 20210

Careers for Women in Conservation

From:
Vocational Guidance Manuals
235 East 45th Street
New York, NY 10017

Opportunities in Environmental Careers

Each of the colleges and universities offering courses in forestry and wildlife usually have brochures available outlining educational requirements.

For further information on forestry and wildlife training available at Purdue University, write directly to:

Dept. of Forestry & Natural Resources
Horticulture Building
Purdue University
West Lafayette, IN 47907

The Extension specialists listed below are also available for consultation or when possible to assist with career guidance programs:

Edgar C. Lott, State Extension Forester;
William L. Fix, Extension Forester; and
Herbert C. Krauch, Jr., Ext. Wildlife Spec.
Dept. of Forestry & Natural Resources
Agricultural Annex II
Purdue University
West Lafayette, IN 47907
Phone: (317) 494-8655

A. N. Liming, Extension Agent-Forestry
P. O. Box 424
Versailles, IN 47042
Phone: (812) 689-6135

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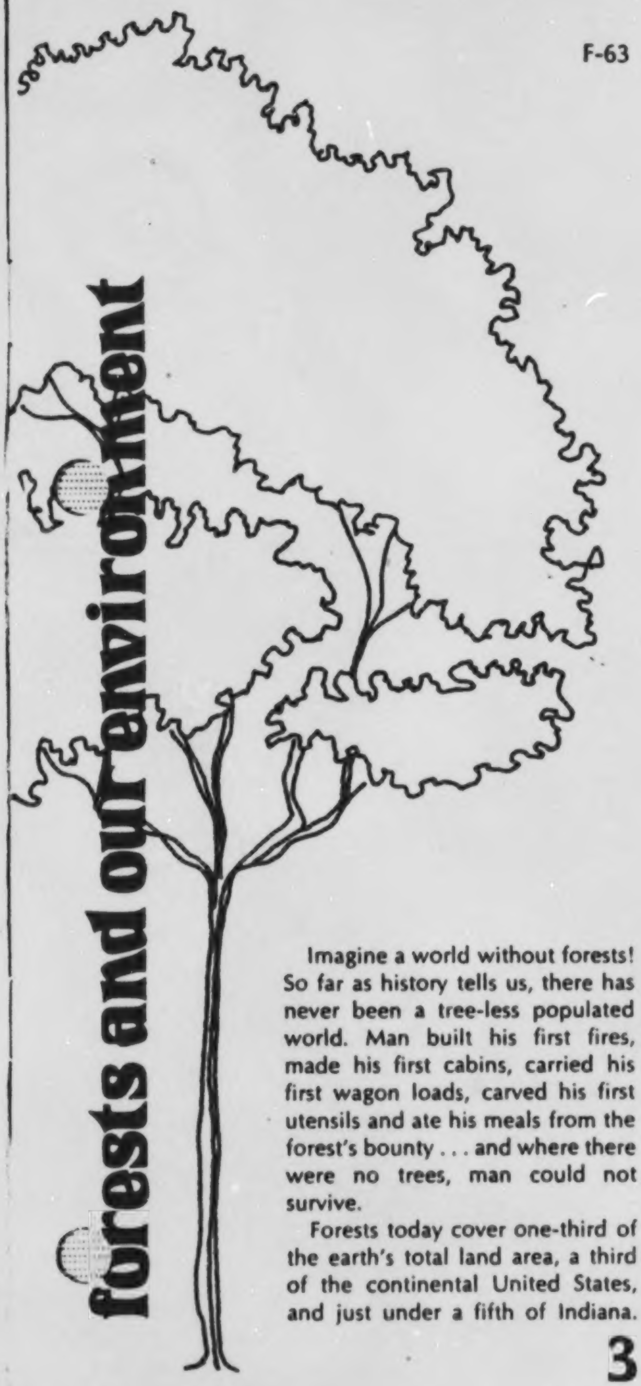
815

forests and our environment

F-63

forests and our environment



Imagine a world without forests! So far as history tells us, there has never been a tree-less populated world. Man built his first fires, made his first cabins, carried his first wagon loads, carved his first utensils and ate his meals from the forest's bounty . . . and where there were no trees, man could not survive.

Forests today cover one-third of the earth's total land area, a third of the continental United States, and just under a fifth of Indiana.

3

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue Univ
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furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service
of Purdue University that all persons shall have equal opportunity and access to its programs and facilities
without regard to race, religion, color, sex or national origin.

Forests are useful. The value of the forest for timber products, wildlife, protection of soil and water, outdoor recreation and natural beauty has long been recognized. But forests serve man in other ways, not so often noticed, but equally vital to life. Forests help provide man with a comfortable and safe environment . . . they clean the air, make oxygen, absorb noises from civilization, remove odors, and help temper the climate. They also provide a place for quiet, rest and inspiration—relief from a hectic world.

The forest is a vital part of man's environment! It not only provides materials for his home, helps to feed him, clothe him, and give him rest, but also protects him from many of his own unpleasantries, keeps him comfortable, and helps to preserve his heritage.

Forests have been part of the earth for all of recorded time, and with careful management, they will continue to serve man.

what is a forest?

A forest is a community of both living things—plants and animals—and non-living substances. Ecology is the study of the relationships between these plants and animals and their environment. When studying a forest community, the ecologist thinks of it in terms of an ecological system, or ecosystem. The idea of the forest as an ecosystem, in which each element is related to the other, is helpful to the understanding of the important role of forests and how they contribute to the quality and stability of our environment.

The hardwood forests of Indiana are complex ecosystems. The trees are members of the group known as hardwoods, which are the broad-leafed trees that shed their leaves in the winter. The ground under the trees is covered with many seedlings, shrubs and plants, while the soil is alive with billions of bacteria, fungi, soil mites, earthworms, insects, and other organisms. Many types of animal life, large and small, are also present in the forest.

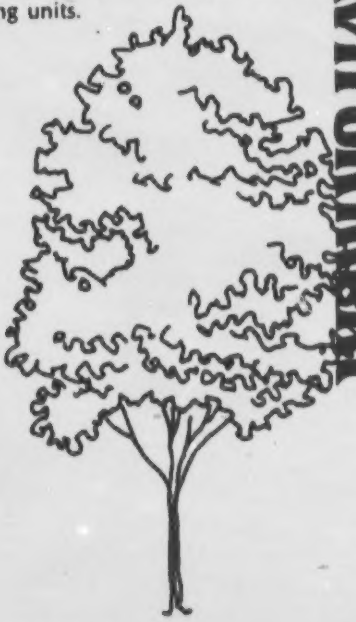
The hardwood forest is also very efficient at conserving plant nutrients. When leaves, twigs, branches and trees die and fall to the ground, they are soon decomposed and returned to the soil. The forest thus re-cycles these materials through its own waste disposal system. The materials and humus covering the soil help to reduce water run-off, and thus reduce the loss of plant foods.

effects of forests on our environment

Forests are one of the most useful, versatile parts of the environment. They serve man both directly and indirectly, from keeping him cool to giving him shelter. Following are some of the benefits of forests.

Reduce Air Temperature: The leaves and branches of trees reduce the amount of sunlight that reaches the ground and act as a blanket to deflect heat radiation from the ground. On a warm summer day, the temperature in a forest may be as much as 8° to 10° F. cooler during the day and 6° F. warmer at night than in nearby open areas.

Transpiration: The movement of moisture from the soil through the trees to the leaves, where it is evaporated, is known as *transpiration*. During a hot summer day a large tree evaporates up to 100 gallons of water, which helps to cool the air. It has been estimated that the cooling effect provided by one large tree may be equal to that produced by five or more room-sized air conditioning units.



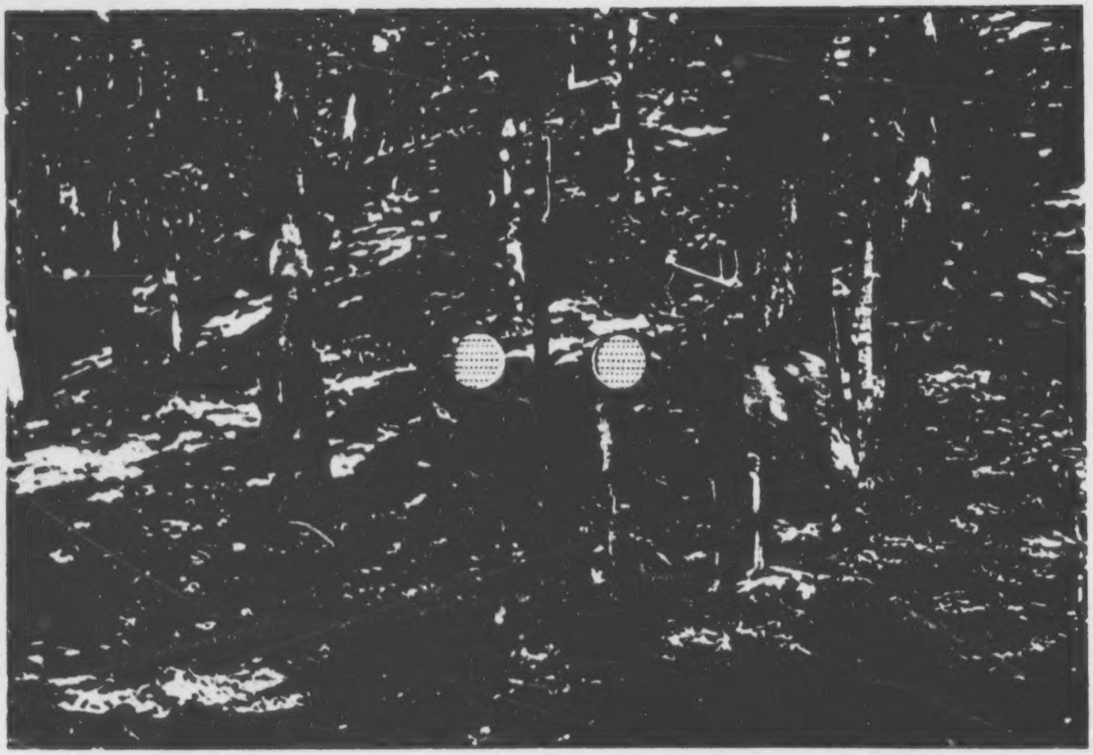
Reduce Wind Velocity: The crowns of trees are effective in slowing wind movement. The extent a forest will decrease wind speed depends on the number of trees per acre and the velocity of the wind. A wind of four miles per hour may be reduced only slightly, while a wind of 30 miles per hour may be reduced to as little as five miles per hour in a dense forest.

Suppress Loud Sounds: Forests absorb sound and make it less intense. A forest or [illegible] border may suppress sound sufficiently [illegible] a noisy location a relatively pleasant place to live. For example, a wooded border 300 to 400 feet deep along a busy highway can suppress traffic noise to a reasonable level for people living near the highway.

Produce Oxygen: As trees use the process of photosynthesis, using sunlight as energy to combine carbon dioxide from the air with water, to manufacture food, oxygen is produced. It has been figured that for every ton of wood grown, forests consume 1.47 tons of carbon dioxide, and release 1.07 tons of oxygen. A mature forest producing very little new growth consumes about as much oxygen as it produces, while a younger, vigorous forest, subjected to timber harvest, produces more oxygen than it uses. Managing forests and trees to keep them healthy and vigorous increases their capacity to perform this important ecological role.

Improve Air Quality: In the process of photosynthesis and respiration forest trees take in and expel large volumes of air. The leaves of the trees effectively intercept and filter dust particles, along with unpleasant odors, from the air. Trees in and around cities have been found to be of major importance in controlling air and noise pollution, as well as for their scenic value.

products and services from our forests



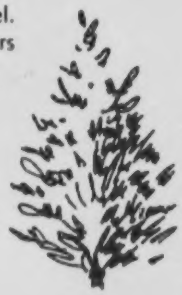
Besides these vital contributions to the environment, our forests provide many economically important products and services; for instance, wildlife habitat, scenic beauty, protection of our soil and water, and forest products of almost unlimited variety.

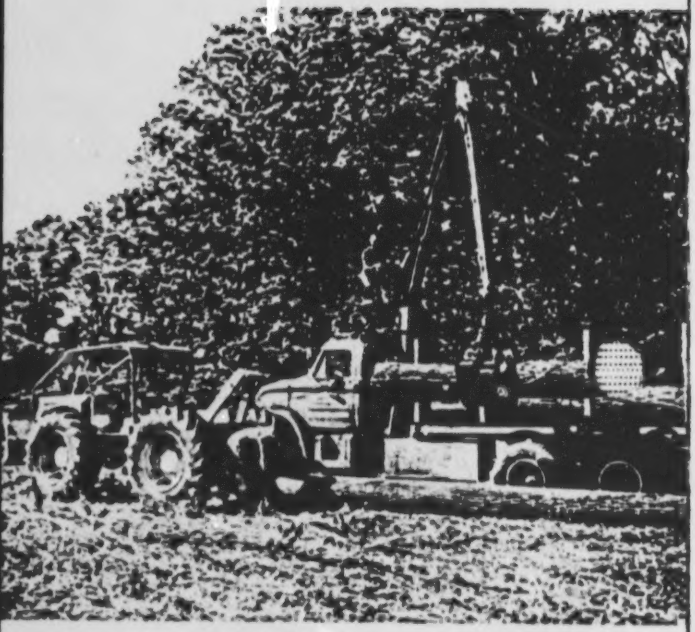
Wildlife: Many wild animals, which are an essential part of the forest ecosystem, depend on the forest for food and shelter. Forests which have scattered openings and borders of shrubs and brush provide excellent habitat for a wide variety of animals. Properly planned timber harvesting encourages the growth and fruiting of small trees and shrubs that provide this food and cover for wild animals.

Timber As A Crop: The trees of the forest are a *renewable natural resource* and with proper management and cutting practices will continue to grow repeated crops. When forests are managed, they are protected from grazing by domestic livestock, from fire, and from insects and diseases. Timber is harvested with good forestry practices, which will assure repeated tree crops for the future. The hardwood forests of Indiana can be managed primarily to grow trees as a crop and to provide wood for many products needed by our growing population.

Scenic Beauty: Forests and trees add beauty and interest to the landscape and they provide the setting for many forms of outdoor recreation. They serve to make life more pleasant, with their beautiful foliage in the fall and bright flowers in the spring.

Protection of Soil and Water: When rain falls on a forest, part of it is intercepted by the tree crowns, branches and foliage, while part of the rain drips from leaves or runs down the tree trunks into the soil. The forest floor, with its fallen leaves, twigs, and branches, cushions the impact of the falling rain, thus preventing rapid water runoff and soil erosion. The loose litter on the forest floor enables water to filter slowly into the soil and reach the ground water level. Thus, forests serve as water regulators and purifiers.



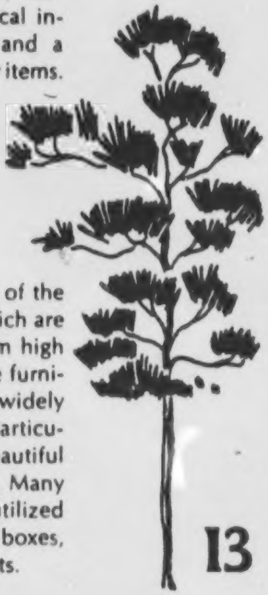


Using good management, including harvest of mature or ripe trees and forest improvement cutting, the timber productivity of the over mature forest, one in which growth is slowed by age, can be increased and maintained at a high level. Thus, the hardwood forest composed of trees of various ages can be managed as a continuous and renewable crop and still provide wildlife, recreation, beauty and many other contributions to a quality environment. This is known as the *multiple*-use management of forest lands.

This is not to deny that there is a need to preserve some mature forests as "reference libraries" and genetic pools. These can serve as guides for forest management decisions and as examples of how natural processes operate.

Forests and Industry: Wise use of wood resources to provide products for everyday use is an excellent way to actually improve the environment. Proper cutting practices help keep the forest young and thrifty. In addition, the process of manufacturing the trees and logs into lumber and other wood products actually uses far less power and causes less pollution than the manufacturing processes needed to produce substitutes, wood imitations and other competitive products. Thus, wood-using industries are utilizing one of our few renewable natural resources to produce many necessary products, and at the same time are improving these resources for future generations.

Indiana is known world-wide for its production of fine hardwood timber. White oak and black walnut logs have long been exported to European countries. Because of their quality, our hardwoods are widely used for such products as fine furniture, baskets, implement handles, musical instruments, ball bats, barrels, and a tremendous variety of every-day items.



Indiana also ranks at the top of the production of face veneers, which are thin sheets of wood sliced from high quality logs and used to surface furniture. Hoosier hardwoods are widely used in home construction, particularly to provide durable and beautiful paneling and hardwood floors. Many of the lesser quality trees are utilized for such things as paper, pallets, boxes, fences and many other products.

Indiana Tree Farm Committee

in cooperation with:

Cooperative Extension Service,
Purdue University

Division of Forestry, Indiana Department
of Natural Resources

U. S. Soil Conservation Service

Indiana Hardwood Lumbermen's Association

U. S. Forest Service

Fine Hardwoods–American Walnut Association

American Forest Institute

15

823

PRODUCTS FROM TREES
PARTIAL LIST

Courtesy of Farm Book Company

LOGS

BOARDS
BOXES
CABINETS
CASKETS
FARM IMPLEMENTS
FLOORING
FURNITURE
MILLWORK
MUSICAL INSTRUMENTS
PARQUETRY
PATTERNS
FLASKS
TANKS
HEAVY JOISTS
PLANKS
SILLS
LAMINATED WOOD
DIMENSION
FINISH
SLABS
FUEL
LATH
SAWDUST AND SHAVINGS
FLOOR SWEEPING COMPOUNDS
INDUSTRIAL ALCOHOL
STOCK FEEDING YEAST
BEDDING FOR ANIMALS
INSULATION
OXALIC ACID
FURNITURE SQUARES
MOLDINGS
MOP HANDLES
DOWELS
PARTICLE BOARD
VENEER
SHINGLES
PLYWOOD
HANDLES

CORDWOOD

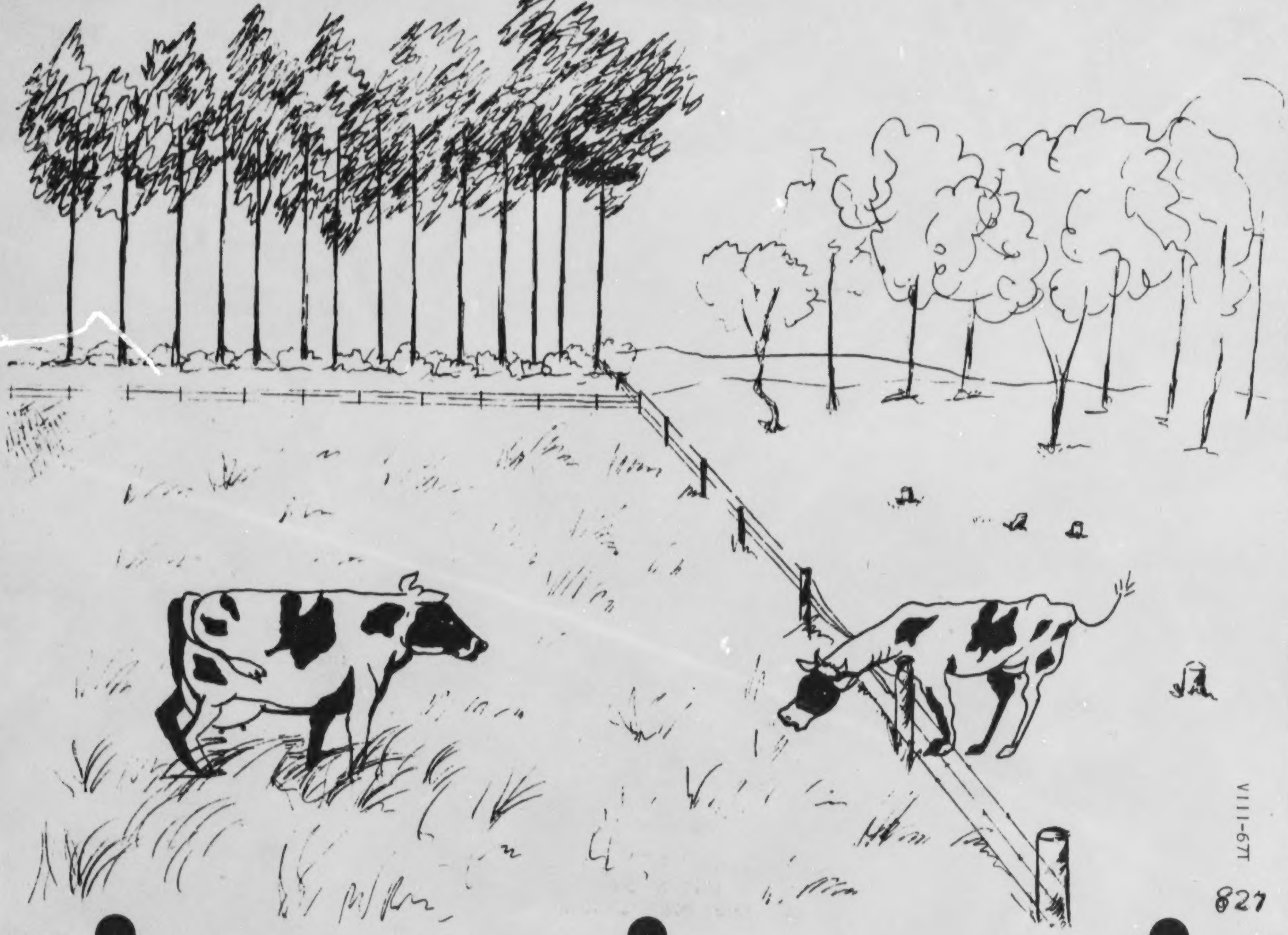
SOIL CONDITIONER
PLASTICS
ROAD BUILDING MATERIALS
TANNING MATERIALS
VANILLIN
RAYON
CELLOPHANE
SAUSAGE CASES
COLLODIO
EXPLOSIVES
PHOTO FILM
CELLULOID
SHATTERPROOF GLASS
SPONGES
IMMITATION LEATHER
ARTIFICIAL HAIR & BRISTLES
SOLID ALCOHOL
MOLDED PLASTICS
PHONOGRAPH RECORDS
NEWSPRINT
WRAPPING
BAGS
BOOKS
WRITING
TISSUE
ABSORBENT
BUILDING
INDUSTRIAL
WALL
BOXBOARD
HARDBOARD
INSULATION BOARD
WALLBOARD

GUMS

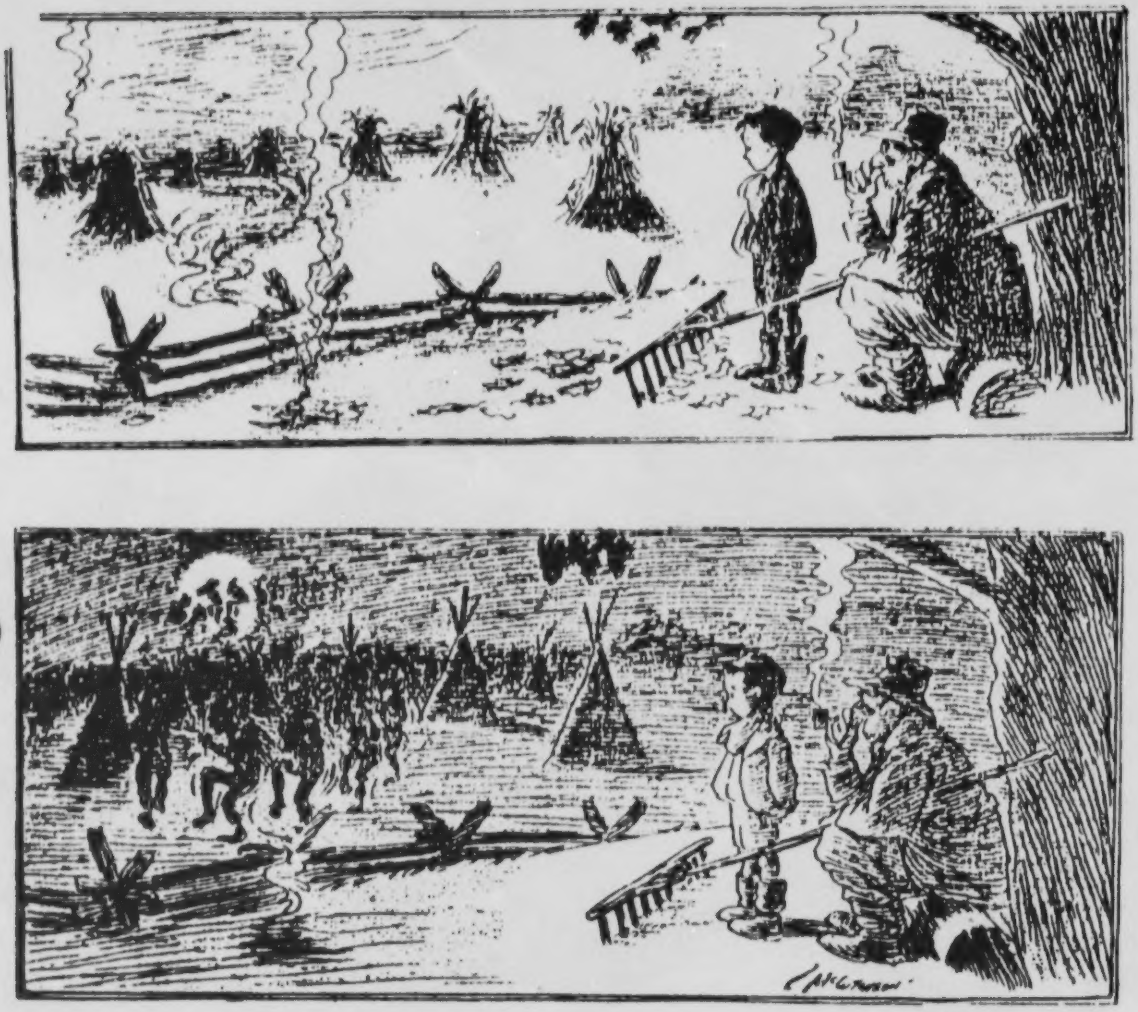
VARNISHES
SOAPS
PAPERSIZES
PAINT DRIERS
GREASES
LEATHER DRESSINGS
GERAMIC ENAMELS
DRUGS
CHEWING GUM
DISINFECTANTS
SOLDER FLUX
ELECTRICAL INSULATION
FIREWORKS & EXPLOSIVES
PRINTING INK
SOLVENTS
ADHESIVES
PAINTS, STAINS
WOOD FILLERS
SHOE POLISH
FLOOR POLISH
CLEANING FLUIDS
SYNTHETIC CAMPHOR
SYNTHETIC SOAP
GREASES & OILS
WAXES
CRAYONS
LABORATORY REAGENTS
INSECTICIDES
OINTMENTS
FLAVORING EXTRACTS
PERFUMES
GLASS CEMENT

VIII-66T

LIVESTOCK WOODS



VIII-67T



INJUN SUMMER

Courtesy of Farm Book Company

LESSON 9: FORESTRY IDENTIFICATION

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Identify the parts of a tree and their function.
2. List seven distinguishing features of trees.
3. Distinguish between an opposite and alternate leaf.
4. Distinguish between an entire, single-toothed, double toothed, and lobed leaf margin from diagrams and samples.
5. Distinguish between scale-like, awl-like and needle-like leaf forms of the confiers from diagrams and samples.
6. Identify a leaf clasp from diagrams and samples.
7. Distinguish between a simple, compound, and doubly compound leaf from diagrams and samples.
8. Identify some common Indiana deciduous trees and shrubs using the summer leaf identification key.
9. Identify some common Indiana evergreens using the provided key.
10. Identify some common Indiana types of wood using the provided key.

MOTIVATION:

1. Discuss with the class why it is important to be able to identify trees.
2. Do you think animals can identify trees? Why?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handouts: "A Key for the Summer Identification of Some Deciduous Trees and Shrubs in Indiana," Purdue University Cooperative Extension Service F-22

"A Key to the Evergreens of Indiana," Purdue University Cooperative Extension Service F-12

"How to Identify Some Common Indiana Woods," Purdue University Cooperative Extension Service F-43

Transparency Master: "Leaf Terms and Forms"

OUTLINE:

A. Parts of a tree and their function

1. Roots

   a. tap root - the main descending axis of a plant, and serving to anchor the tree and to absorb and conduct water and mineral nutrients.
   b. lateral root - a root which grows from the side of the taproot.
   c. root hair - small hair sized roots filtering through the soil making a large absorbtion region possible.

2. Trunk

   a. outer bark - outer protective covering of a tree
   b. inner bark - protective covering of the cambium of the tree
   c. cambium - the layer of tissue, one or two cells thick, just inside the inner bark resulting in growth in diameter of a tree.
   d. sapwood - wood that conducts fluids for the tree
   e. heartwood - wood in the center of the stem that no longer grows or conducts fluids.

3. Crown

   a. branches - any division or sub-division from the main stem
   b. twigs - any division from a branch
   c. leaves - trap sunlight, absorb and store energy through photosynthesis
   d. buds - the rudimentary state of a stem or branch; an unexpanded flower
   e. flowers - floral leaves grouped together on a stem and adapted for sexual reproduction
   f. fruit - the seed bearing product of a plant
   g. seed - the ripened ovule consisting of the embryo and its essential coats

B. Seven distinguishing features of trees

1. Leaves

2. Twigs and Buds

3. Flowers

4. Fruit

5. Seeds

6. Bark

7. Branching Form

C. The difference between an opposite, alternate, simple, compound, doubly compound leaf. Between entire, singly-toothed, doubly-toothed, and lobed leaf margin. Between awl-like, scale-like, and needle-like forms of confirms. A leaf clasp. (see transparency on Leaf Terms and Forms)

D. Hardoowd Identification (see "A Key to the Summer Identification of Some Deciduous Trees and Shrubs in Indiana) F-22

E. Evergreen Identification (see "A Key to the Evergreens of Indiana:) F-12

F. Indiana Wood Identification (see "How to Identify Some Common Indiana Woods") F-43

TEACHING LEARNING ACTIVITIES:

1. On a diagram of a tree, or on a real tree, have the students label all parts and describe the function of each.

2. Cut and dissect several different species of trees and examine the differences in heartwood, sapwood, cambium etc.

3. Show the transparency master, "Leaf Terms for the Hardwoods and Leaf Forms for the Confirms." Discuss how leaf arrangements differ.

4. Identify selected leaf samples of the teachers choice, identifying different leaf arrangements.

5. Supply students with handout, "A Key for the Summer Identification of Some Deciduous Trees and Shrubs of Indiana, " and discuss with the students on how to use the key.

6. Identify selected deciduous trees and shrubs of the instructor's choice.

7. Supply students with handout, "A Key to the Evergreens of Indiana, " and discuss with the students how to use the key.

8. Identify some selected evergreens of the instructor's choice.

9. Supply students with handout, "How to Identify Some Common Indiana Woods," and discuss with the students how to use the key.
10. Identify some selected Indiana woods of the instructor's choice.
11. On a field trip, observe different tree species that are present on lowland, upland, swampy areas, etc.

EVALUATION:

1. Give the students an identification quiz of selected leaf specimens of the instructor's choice.

Notes on Forestry and Wood-use

Purdue University
Cooperative Extension Service
West Lafayette, Indiana 47907

F-12

A KEY TO THE EVERGREENS OF INDIANA

(Native and Introduced)*

Edgar J. Lott, Extension Forester

How to Use the Key

As you will note, the key is composed of matched "leads" or choices, each set of which is numbered the same. The first step in using the key, is to decide which one of the first two leads fits the tree being identified. The number at the righthand margin, opposite the choice selected, will then tell which set of leads you should go to next. In this fashion, proceed through the key until you come to the name of your tree.

To use the key, it will be necessary to learn a few new words. For example, the pines have their needles attached to the twig in small groups, called "fascicles." The needles, in a fascicle, usually 2, 3 or 5 in number, are bound together at the base with a small, brown membrane or sheath. The booklet entitled Fifty Trees of Indiana contains descriptive sketches of the needle and other leaf forms of the evergreens, and should be used as a reference with this key. It can be obtained at small cost from the Division of Forestry, 613 State Office Building, Indianapolis, Indiana 46204.

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*Includes the pines of Indiana (native and introduced) and nine other genera of native and introduced cone-bearing trees commonly found in the state.

Rp. 4-74-3M

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Indiana. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

1.	Leaves needle-like (linear)	2
1.	Leaves awl-shaped and/or scale-like	12
2.	Needles born singly on the branchlets	13
2.	Needles in fascicles of 2-5 or in clusters of 10 or more on short spurs	3
3.	Needles in fascicles of 2-5	4
3.	Needles in clusters of 10 or more on short spurs on old growth and singly on new growth, deciduous	Larches
4.	Needles in fascicles of 5	White Pine*
4.	Needles in fascicles of less than 5	5
5.	Needles in fascicles of 2, 4-6 inches long	6
5.	Needles in fascicles of 3, or if in 2's or 2's and 3's, less than 4-6 inches long	7
6.	Needles flexible, soft; buds brown	Red Pine*
6.	Needles stiff, sharp pointed; buds conspicuous, white	Austrian Pine*
7.	Needles in fascicles of 3	8
7.	Needles in fascicles of 2 or 2 and 3	9
8.	Needles 4-8 inches long, pale green, slender, slightly stiff	Loblolly Pine
8.	Needles 3-4 inches long, dark yellow green, stout, standing stiffly at right angles to branchlets	Pitch Pine
9.	Needles in 2's and in 2's and 3's	10
9.	Needles in 2's only	11
10.	Needles in 2's (rarely in 3's), 1-$1\frac{1}{2}$ inches long, stout, twisted, arranged sparsely and irregularly on branchlets, twigs with purplish bloom.	Virginia Pine
10.	Needles in 2's and 3's, 3-4 inches long, slender, flexible, not twisted, somewhat tufted at ends of branchlets	Shortleaf Pine
11.	Needles 1-$1\frac{1}{2}$ inches long, stout, twisted, divergent; buds resinous; cones unsymmetrical, pointing toward ends of branchlets	Jack Pine
11.	Needles $1\frac{1}{2}$-3 inches long, blue green (occasionally yellow green); cones symmetrical, pointing toward base of branchlets	Scotch Pine*
12.	Leaves both awl-shaped and scale-like; fruit a berry	Junipers
12.	Leaves scale-like in fan-shaped sprays; fruit a cone	Arborvitae
13.	Needles angular in cross-section (either triangular or square); branchlets with peg-like projections	Spruces
13.	Needles flat in cross-section	14
14.	Branchlets slender; needles $\frac{1}{2}$-1 inch long	15
14.	Branchlets stout; needles 1 inch or more in length	17
15.	Needles 2-ranked; needles $\frac{1}{2}$" long, deciduous	Bald Cypress
15.	Needles 2-ranked; needles persistent	16
16.	Needles 2-ranked with some needles lying along top of branchlets	Hemlock
16.	Needles 2-ranked; petioles slender, yellow	Yew
17.	Buds blunt, often resinous	Firs
17.	Buds brown, long pointed, many-scaled	Douglas Fir

* These pines have "regular" growth; that is, they produce one whorl of lateral branches each year. The other pines have "irregular" growth; that is, they produce two or three whorls of lateral branches each year, and have a more "ragged" appearance.

Notes on Forestry and Wood-use

Purdue University,
Cooperative Extension Service
West Lafayette, Indiana 47907

F-22

A KEY FOR THE SUMMER IDENTIFICATION OF SOME DECIDUOUS TREES & SHRUBS IN INDIANA

by E. J. Lott

1. Leaves opposite 2
1. Leaves alternate 13

2. Leaves simple 3
2. Leaves compound 10

3. Leaves 3-5 lobed 4
3. Leaves not lobed 7

4. Leaves with rounded sinuses and coarse teeth 5
4. Leaves with acute sinuses and fine teeth 6

5. Usually 5-lobed, in a flat plane, without stipules ----------- Sugar Maple
5. Usually 3-lobed, leaves drooping, broader than preceding, stipules often present-- Black Maple

6. Deeply-cut leaves, 5-lobed, silvery beneath; found near streams or on wet sites --- Silver Maple
6. Not so deeply-cut, usually 3-lobed, smaller preceding; found on both wet & dry sites --- Red Maple

7. Leaves about 8" in length, 6" in width 8
7. Leaves 3" - 4" long, 2" - 3" broad 9

8. Stout twigs with solid pith; white flowers; cigar-shaped fruit pods; leaves usually in whorls of 3 -- Catalpa
8. Large twigs with hollow pith; tips often winter-killed; purple flowers; ovoid, pointed fruit pods; leaves rarely in whorls of three--- Empress Tree*

9. Oval leaf, with parallel leaf veins curved toward tip; alligator bark; buttonlike flower buds and small pointed leaf buds; fruit a cluster of green berries which turn red in the fall ----------------- Flowering Dogwood
9. Leaves almost heart-shaped, with netted veins; fruit a two-celled capsule, with 2 seeds in each cell; buds almost round, with several scales ---- Lilac**

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* An exotic tree which has escaped frequently in southern Indiana.

** An exotic shrub which has been planted extensively in Indiana.

10. Leaves pinnately compound 11
10. Leaves palmately compound 12

11. 3-5 leaflets with margins irregularly notched; round, green twigs, with small white buds -- Boxelder
11. 7 leaflets with entire margins; gray-brown twigs, flattened at the nodes -- White Ash

12. 5 leaflets; buds not resinous ---------------------------- Ohio Buckeye
12. 7 leaflets; buds resinous ---------------------------- Horse-Chestnut***

13. Leaves simple 14
13. Leaves compound 37
13. Leaves doubly compound 42

14. Leaves of several different shapes on the same tree 15
14. Leaves not variable in shape 16

15. Leaves entire or 2- or 3-lobed, all on same tree; green aromatic twigs; reddish-colored bark -- Sassafras
15. Leaves with coarsely-toothed margins (preceding have entire margins) , usually not as variable as sassafras; yellow-barked roots; fruit resembles that of blackberry -- Red Mulberry****

16. Long leaf stems 17
16. Short leaf stems 22

17. Leaf stems flat 18
17. Leaf stems round 19

18. Leaves triangular with stout, flat stems; twigs often ridged; buds large and glossy -- Cottonwood
18. Leaves triangular to round, with coarse teeth on margins; and with fine, flat stems; twigs smooth; buds dusty-looking ------------- Largetooth Aspen

19. Stipules or stipule scars present... 20
19. Stipules absent 21

20. Large, maple-like, 3-5 lobed leaves; swollen base of leaf, stem completely covers bud; whitish bark which scales off in patches; fruit a smooth ball hung on a stem -- Sycamore
20. 3-lobed leaves, with the top lobe widely-notched; fruit resembles a little, dry pineapple; tulip-like flowers ------------------------------ Tuliptree

21. Heart-shaped leaves with entire margins; both ends of leaf stem enlarged; fruit a thin, 3-inch pod-- Redbud
21. Star-shaped leaves; corky wings on twigs; fruit a spiny ball; river bottoms and wet lands of southern Indiana ------------------------------ Sweet Gum
21. Heart-shaped leaves with lopsided bases and finely-toothed margins; several small, round, nut-like seeds, suspended by a stem from a leaflike wing------ Basswood or Linden

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*** An exotic tree which has been planted widely in Indiana.

**** Many escaped, exotic mulberries will be found which have extremely variable leaves.

22. Twigs bearing single, short thorns at the nodes, fruit a "hedge-apple" -- Osage-orange
22. Twigs without thorns 23

23. Long, narrow leaves, with stipules; fine twigs------------------------ Willows
23. Leaves without stipules 24

24. Sturdy trees bearing acorns; stout twigs with clustered terminal buds 25
24. Trees without acorns; terminal buds not clustered 32

25. Leaves with rounded or blunt-pointed lobes - no bristles on tips; acorns maturing in one year; bark gray except in one species 26
25. Leaves with bristle-pointed tips (except in one species which has entire leaves); acorns maturing in 2 years; bark usually dark in color 29

26. Leaves with rounded lobes and deeply-cleft sinuses 27
26. Leaves with "Wavy" margins and shallow sinuses 28

27. Rounded-lobed leaves, deeply and evenly cleft ----------------------White Oak
27. Rounded-lobed leaves, with terminal lobe much larger than others, and cleft nearly to midrib at center of leaf; corky ridges often found on vigorous twigs -- Bur Oak

28. Leaves with shallow-lobed margins, dark green and leather-looking on upper surfaces, duller green beneath, prominent dark-colored, sharply-ridged, deep fissured bark, frequents dry ridge tops -------------- Chestnut Oak
28. Wavy-margined leaves, not darker green and leathery-looking above as in chestnut oak, gray bark like white oak, frequents limestone soils -- Chinquapin Oak
28. Leaves wider toward tip, with wavy margins or blunt teeth; bark like white oak, young bark often peels back on smaller limbs; acorns borne on very long **stalks**, found in wet places, often with sweet gum, pin oak, soft maples, white elm, amd other wet land species ----------------------- Swamp White Oak

29. Leaves with bristled-tipped lobes 30
29. Entire-margined, straplike leaves 31

30. 7- to 9-lobed leaves, with clefts reaching halfway to midrib, diminishing regularly to wedge-shaped base; young bark smooth and dark green, gradually breaking into flat light-colored ridges, with pink inner bark; an inch-long acorn, set in saucer-like cup --- Red Oak
30. 7-lobed leaves, extremely variable in shape, with dark, leather-looking upper surfaces; bark dark and "blocky" in appearance, with yellow inner bark; ½ inch acorn in a bowl-like cup ------------------------------------Black Oak
30. Leaves smaller than preceding with 5 to 7 lobes, cut almost to midrib, bark dark and tight; pinlike branches on limbs, little acorns in shallow cups, a tree of the wet lands --- Pin Oak

31. Strap-like, entire leaves; bark and form like pin oak, but without the pin-like branches -- Shingle Oak

32. Leaves with coarsely doubly-serrate margins and lopsided bases; rough, often with heavily buttressed bases 33
32. Trees not as above 34

33. Leaves quite rough; gray twigs, noticeably rough to the touch; bark ridges vertical; bark cross-section shows even red color throughout----------- Red Elm
33. Leaves smaller than preceding, and smooth to slightly rough; brown twigs smooth to slightly rough; bark ridges criss-cross; bark cross-section shows red and white alternating layers -- White Elm

34. Trees with smooth, gray bark 35
34. Trees not having smooth, gray bark 36

35. Small trees with very fine twigs, and bark with strong, muscular ridges -- Blue Beech
35. Large trees with bark not fluted or ridged------------------------------ Beech

36. Small trees with fine twigs and "shreddy" bark --------------------- Ironwood
36. Trees with right-angled branching & "blocky" bark; leaves clustered at tips of branches --- Black Gum
36. Trees with "blocky" bark, showing orange inner bark in crevices between the blocks; plum-like fruit resting on a flat, woody calyx--------------Persimmon
36. Trees with black bark broken into small, 1-inch square plates showing transverse lenticels; fine twigs with a bitter taste and a sour smell, fruit clusters of small, black cherries ------------------------ Wild Black Cherry

37. Trees with small thorns in pairs, one on either side of the juncture of the leaf stem with the twig 38
37. Trees without thorns 39

38. 7-17 leaflets; white, fragrant flowers in long, dense clusters; 3-inch, brown to black pods; deeply-fissured brown to black bark -------------- Black Locust
38. 5-11 leaflets; dark green above, lighter and pubescent beneath; prickles on leaf stems; shrub or small tree, bearing a strong resemblance to young black locust trees -- N. Prickly Ash

39. 11-23 leaflets; pith chambered, fruit husks do not split open, shell of nuts sculptured 40
39. 5-11 leaflets; solid pith; fruit husks split open; shell of nut smooth or slightly ridged 41

40. 13-23 leaflets; pith tan in color; fruit almost round; bark chocolate-colored and roughly ridged --- Black Walnut
40. 11-21 leaflets; pith chocolate-colored; fruit oblong, with a hairy, sticky husk, gray bark with flat, shallow ridges ------------------------ Butternut

41. 5 leaflets, the terminal 3 much larger than the basal pair; bark "shaggy" on trees more than 5 inches in diameter ------------------- Shagbark Hickory

41. 5 leaflets (occasionally 7); bark dark gray, close and tight; twigs and buds much finer and smaller than preceding ----------------------- Pignut Hictory

41. 5-9 leaflets (rarely 11); distinctive sulfur-yellow buds; fine twigs; thin, tight, gray bark --- Butternut Hickory

42. Leaves both singly and doubly compound, with very small leaflets; fruit a long thin, "wavy-shaped", glossy-brown pod; long, branched thorns on twigs and trunk; bark dark and tight ---------------------------------- Honey Locust

42. Doubly-compound leaves, often 2 feet long; fruit a thickshelled, brown pod, containing large, bony seeds; the shallow bark ridges have very sharp, wavy edges; the clublike twigs are mottled in color ------- Kentucky Coffee-tree

42. Very large doubly-compound leaves, often prickly above, white flowers in large panicles; very stout stems, covered with prickles; small tree --- Hercules' Club

Note: The above Key is based largely on summer characteristics including leaves. To recognize trees in winter other Keys have been developed such as Harlow's Twig Key to the Deciduous Woody Plants of Eastern North America. After you have learned to use the present Key, it is good experience to use other standard Keys. The following are suggested.

Harlow: Trees of Eastern United States and Canada.
McGraw Hill Book Company, New York

Otis: Michigan Trees. University of Michigan Press, Ann Arbor, MI

Deam: Trees of Indiana. Indiana Department of Natural Resources, State Office Bldg., Indianapolis, IN 46204

Further information or additional copies of this publication can be obtained through your county agent or nearest forester, or the Department of Forestry and Natural Resources at Purdue University, West Lafayette, Indiana 47907.

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FNR 43
1977

forestry &
natural
ENVIRONMENTAL FORESTRY resources

How to Identify Some Common Indiana Woods

by W. L. Fix, Extension Forester

Woods differ in strength, hardness, color, odor, weight and other properties, as well as their structure. These differences can be used in their identification.

To identify an unknown wood, cut a smooth surface on the end or cross section of the sample with a sharp knife. Here you will see the annual rings just as they appear on a stump in the woods. Using a hand lens, check to see if openings, called **pores** can be seen within the annual rings. The pores, easily seen in oaks, ash, and hickory, are tubes which carry water and nutrients from the tree roots to the leaves.

In some hardwood (broadleaf) trees, the pores may be larger on one side of the annual ring. The area containing the larger pores, which is always on the side of the annual ring toward the center of the tree, is called **springwood** and grew during the early spring season. The area of smaller pores, along the outside of the annual ring, grew during the summer and so is called **summerwood.** Thus, an annual ring is actually made up of a band of springwood and a band of summerwood.

Woods having large pores in the springwood and small pores in the summerwood are called **ring-porous** woods. These include the oaks, elm, ash, and others.

Woods having springwood and summerwood pores about the same size are called **diffuse-porous**. Among others, these include sycamore, tuliptree, beech and the maples. A few other woods, such as walnut and cherry, have a gradual change from larger springwood pores to smaller summerwood pores. These are often called **semi-ring-porous** woods. The first step, then, in wood identification of the hardwoods is to separate the woods into one of these groups.

In a few species the large springwood pores may appear under the hand lens to be closed, or filled. White oak is a member of this group (see sketch).

In some species, groups of cells will be found in the summerwood arranged in various patterns. These may be roughly triangular (as in white oak), in short lines (as in red oak), wavy horizontal bars (as in red elm), in small isolated clusters, or may appear as more or less continuous fine lines (as in hickory). These serve as additional aids to identification of many species.

Wood Rays

Look again at the cross section of white or red oak. You will see ribbon-like streaks or lines running across the annual rings from the center of the tree to the outside. These are rows of cells which give oak some of its figure and are known as **wood rays.** Rays serve to transport substance laterally within the tree, for food storage and vary in size among species. In cottonwood, for example, they are not usually visible to the naked eye. Rays also appear more numerous in some kinds of wood than in others. Therefore, both the size and number of rays are used in wood identification. Rays are large and easily seen in oak, beech and sycamore. Rays in tuliptree, sweetgum and basswood appear much less distinct to the naked eye. The rays may also vary in size in any one species. White oak, for example, has some wide and very conspicuous rays and others, in between, that are narrow and indistinct. In black walnut the rays are quite uniform in width and indistinct without a hand lens.

Color, Hardness, and Figure

Color, degree of hardness, and figure are also used to assist in identification of woods. **Sapwood,** the outer living portion of the stem, is usually lighter in color than the **Heartwood,** the dead inner wood near the center of a tree. Hardness may be tested by a finger nail. Soft woods, such as basswood and cottonwood, are easily indented. Hard woods, such

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as sugar maple, beech and the oaks, cannot be indented in this way. Sometimes the taste or odor, as in sassafras may be noted.

Figure in a wood generally refers to the distinct markings on the face of a wood sample. It is due to differences between the springwood and summerwood (pore size), the presence of wood rays, and the structure of the wood. Some woods, such as basswood and cottonwood, have little or no figure. Others, such as oak, walnut and maple, are well known for their pleasing figure.

Parenchyma

Characteristic white markings may also be seen on the cross section. These are **parenchyma** cells which serve to store food. The parenchyma cells may surround or connect the pores, or be completely independent of any pores. In woods like hickory, the parenchyma appears as fine concentric bands and is not associated with the pores. In summerwood of elm, the parenchyma connects the pores in wavy concentric bands. In ash, the parenchyma forms a narrow sheath about the pores and sometimes unites them laterally toward the outer margin of the ring.

A Key to Sixteen Common Indiana Hardwoods

All of the wood structures and properties of woods described above are used in the **Identification Key** in this leaflet. The sketches and photographs which follow will help you to find the various parts of the wood samples. You will need to refer to them until the terms become familiar.

To use the Key, look at the cross section of the wood samples. Make a smooth cut with a sharp knife so that the features used for identification can be clearly seen. A hand lens or magnifying glass will be helpful.

The Key is constructed so that a series of alternative choices must be made from pairs of descriptions. By selecting the choice describing the wood to be identified, the point is ultimately reached where the name of the wood is given. Check your identification by comparing the sample with the illustrations.

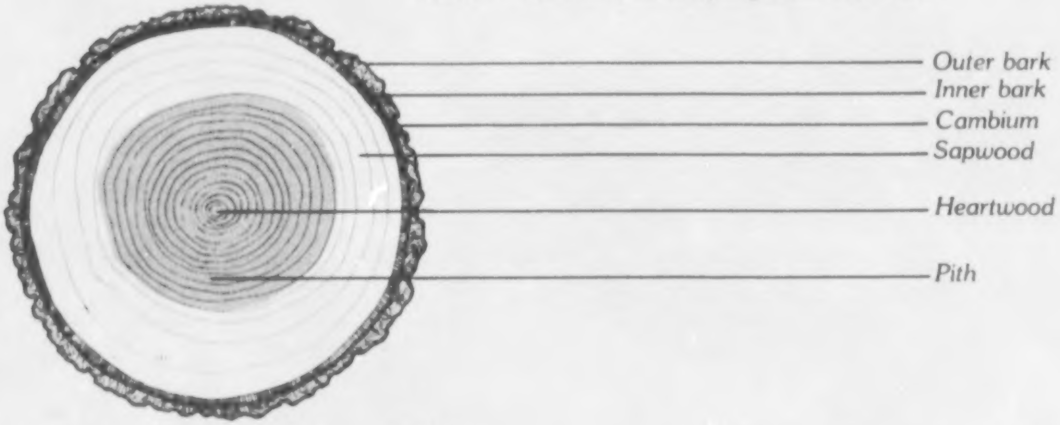
References

Panshin, A.J. and de Zeeuw, C., 1970. *Textbook of Wood Technology*, Vol. 1., 3rd Edition. New York: McGraw-Hill, 1970.

U.S. Forest Products Laboratory. *Wood Handbook: Wood As An Engineering Material.* USDA Agr. Handbook 72, rev. 1974. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $7.85. Give stock No 0100-03200 when ordering.

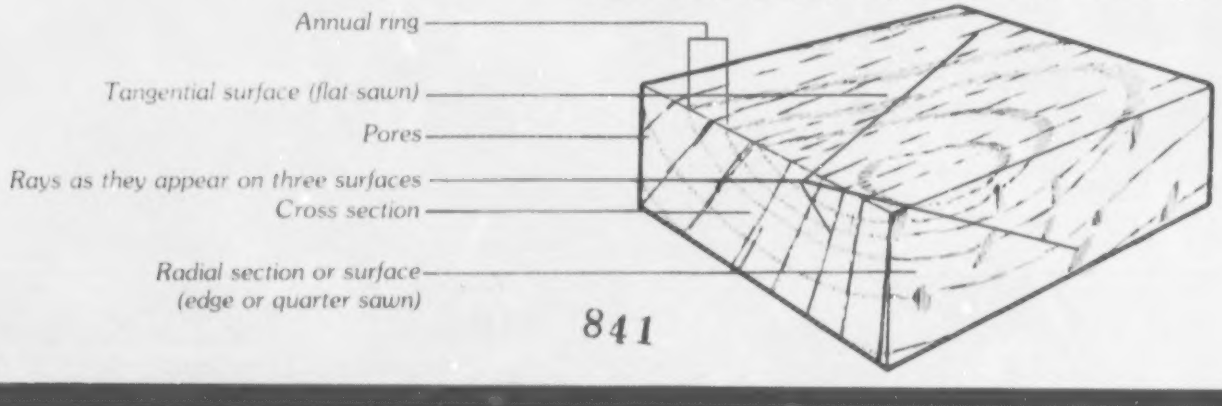
Wood...Colors and Kinds. USDA Agr. Handbook No. 101., 1956. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 50¢.

Terms Used in Identifying Hardwoods

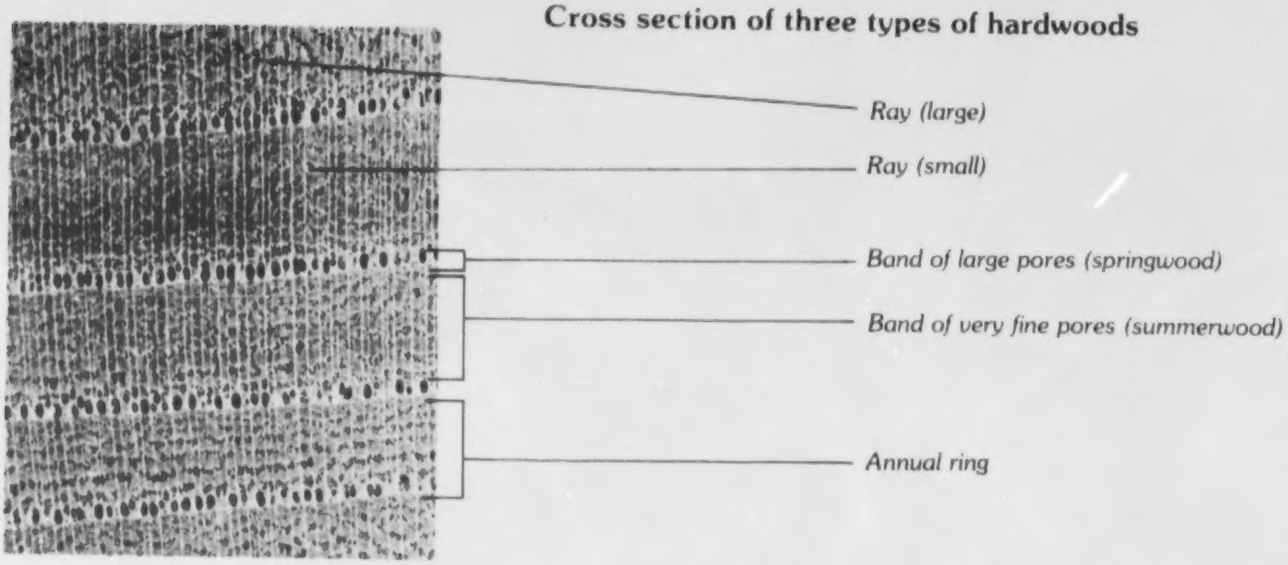


Cross section of a tree trunk or log

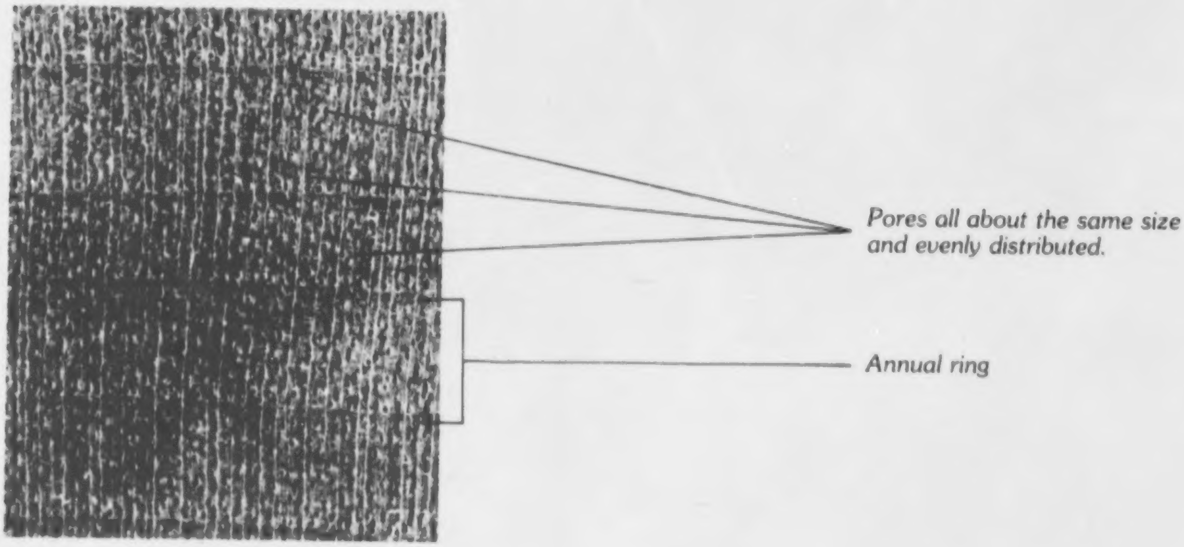
Sketch of an oak board showing three surfaces with characteristics as they appear to the unaided eye.


Annual ring
Tangential surface (flat sawn)
Pores
Rays as they appear on three surfaces
Cross section
Radial section or surface (edge or quarter sawn)

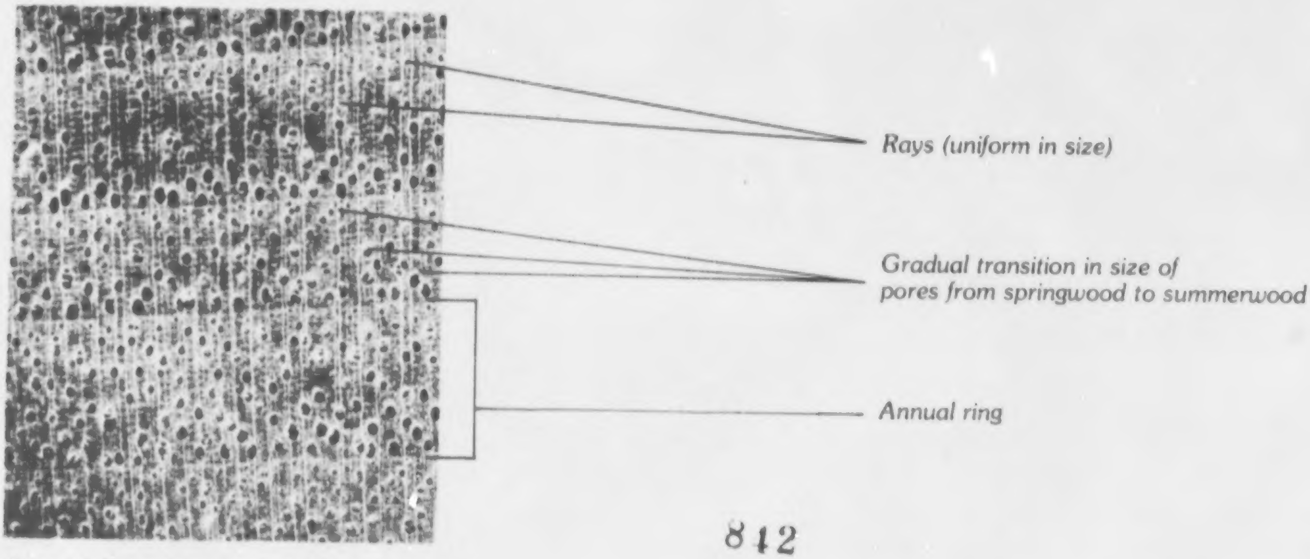
Cross section of three types of hardwoods


Ray (large)
Ray (small)
Band of large pores (springwood)
Band of very fine pores (summerwood)
Annual ring

A ring-porous wood (Red Oak)

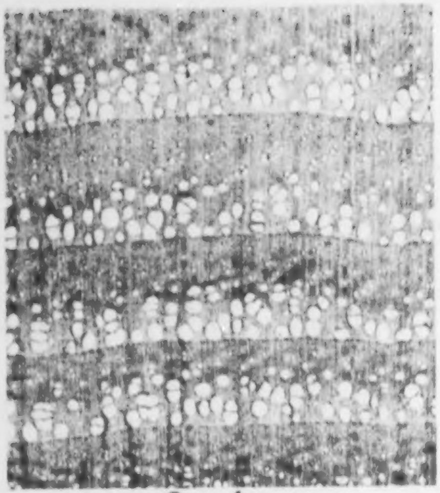

Pores all about the same size and evenly distributed.
Annual ring

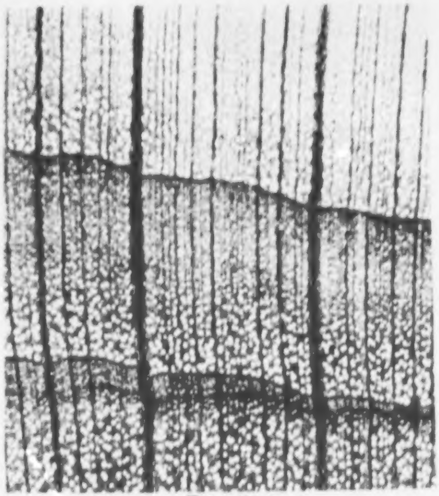
A diffuse-porous wood (Birch)

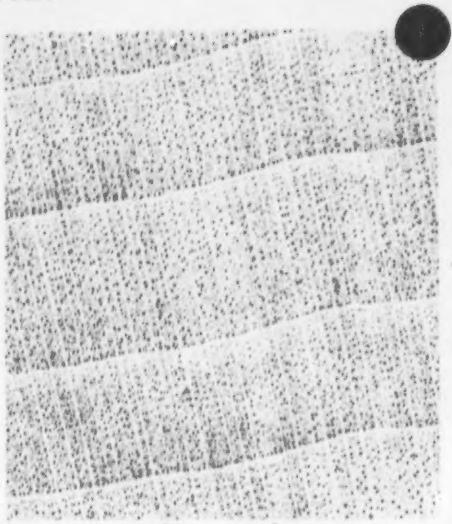

Rays (uniform in size)
Gradual transition in size of pores from springwood to summerwood
Annual ring

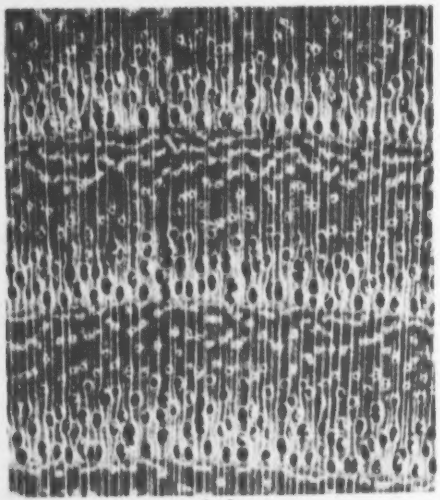
A semi-ring porous wood (Black Walnut)

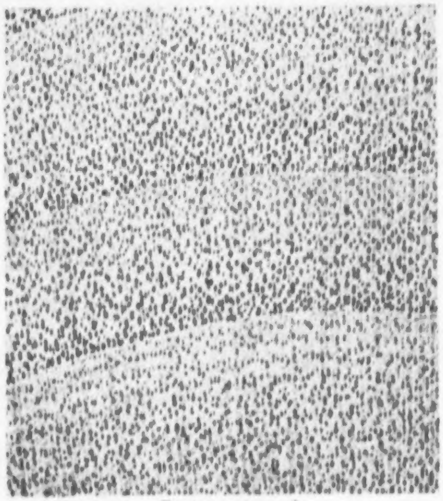
Selected Cross Sections of Indiana Woods

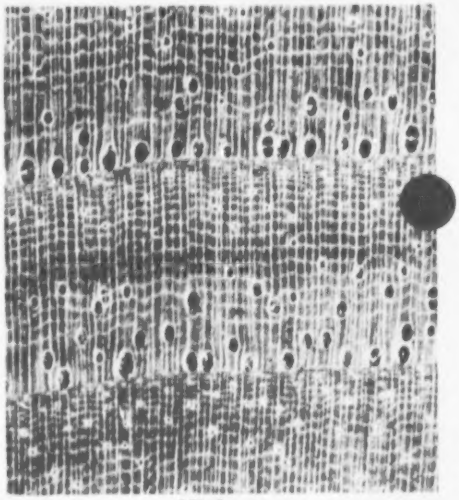

Sassafras

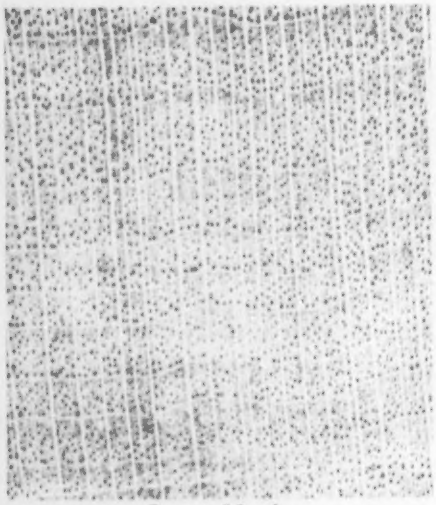

Beech

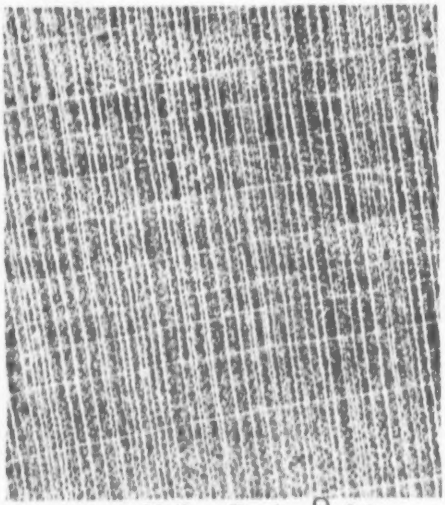

Basswood

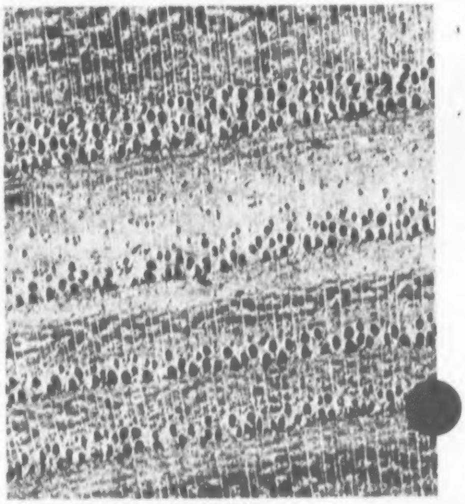

Ash


Cottonwood


Hickory


Sugar Maple


Yellow Poplar


Red Elm

A Key to 16 Common Indiana Woods

1	Wood ring porous	2
1	Wood diffuse porous	11
2	Rays readily visible to the naked eye	3
2	Rays not readily visible to the naked eye	4
3	Pores occluded with tyloses color light to dark brown	**White Oak Group**
3	Pores not occluded with tyloses color reddish-brown	**Red Oak Group**
4	Abrupt change in size of pores from springwood to summerwood (ring-porous)	5
4	Gradual change in size of pores from springwood to summerwood (semi-ring porous)	9
5	Summerwood figured with conspicuous wavy concentric bands of pores which are mostly continuous	6
5	Summerwood not figured by conspicuous wavy concentric bands of pores	7
6	Springwood pores mostly one row wide, heartwood greyish brown	**American Elm**
6	Springwood pores 2-4 rows wide, heartwood dark brown	**Slippery Elm**
7	Wood with aromatic odor, heartwood reddish brown	**Sassafras**
7	Wood odorless	8
8	Summerwood parenchyma as numerous concentric fine lines	**Hickory**
8	Summerwood parenchyma not conspicuous, pores in clusters of 2-3	**Ash**
9	Rays readily visible to naked eye, heartwood red to reddish brown	**Black Cherry**
9	Rays indistinct to the naked eye, heartwood whitish or chocolate brown	10
10	Pores very numerous, heartwood greyish white to light brown, wood light weight	**Cottonwood**
10	Pores scattered, heartwood chocolate brown in color	**Black Walnut**
11	Rays conspicuous to the naked eye	12
11	Rays not conspicuous to the naked eye	15
12	Rays wider than the pores	13
12	Rays narrower than the pores	14
13	Broad rays separated by several small rays	**Beech**
13	Rays of nearly uniform width closely spaced	**Sycamore**
14	Rays variable in width, wood hard, heartwood light reddish brown	**Sugar Maple**
14	Rays nearly uniform in width, wood moderately soft, heartwood greenish yellow, sometimes darker brown upon exposure	**Tuliptree**
15	Pores usually slightly larger in the springwood, heartwood greyish to pale brown	**Cottonwood**
15	Pores uniform in size throughout the annual ring	16
16	Rays very closely spaced, heartwood reddish brown	**Sweetgum**
16	Rays normally spaced, heartwood pale brown	**Basswood**

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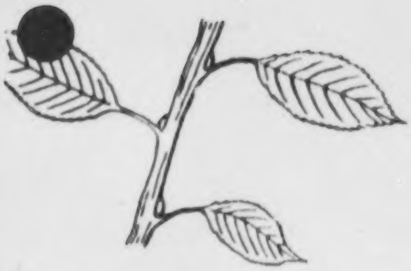
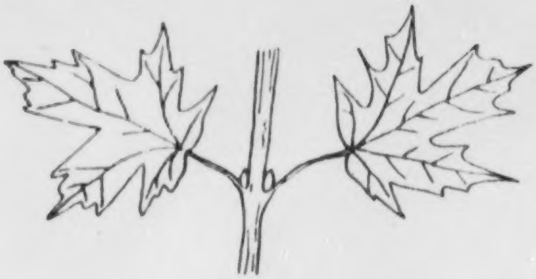
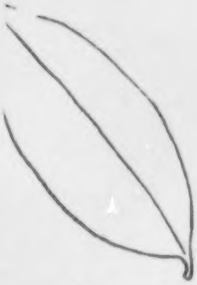
LEAF TERMS FOR THE HARDWOODS

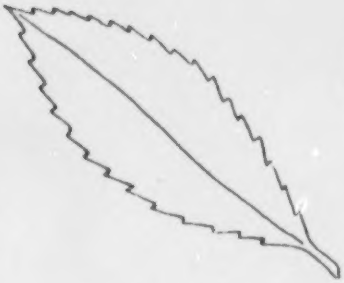
LEAF ARRANGEMENT (Branching)

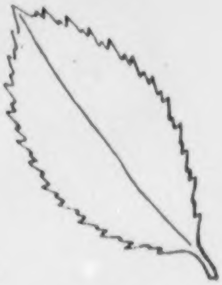

Alternate

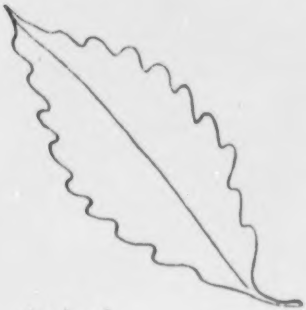

Opposite

SIMPLE LEAVES

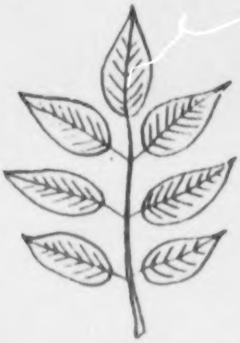

Entire

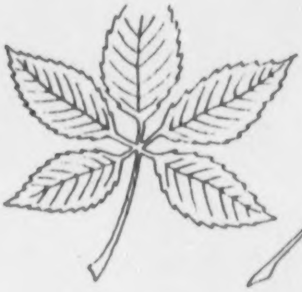

Singly-toothed

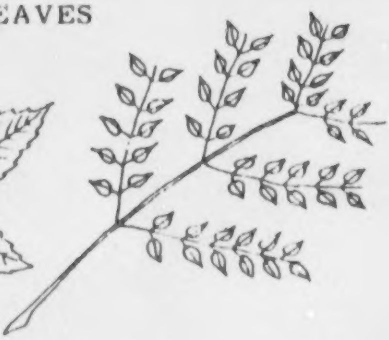

Doubly-toothed


Lobed

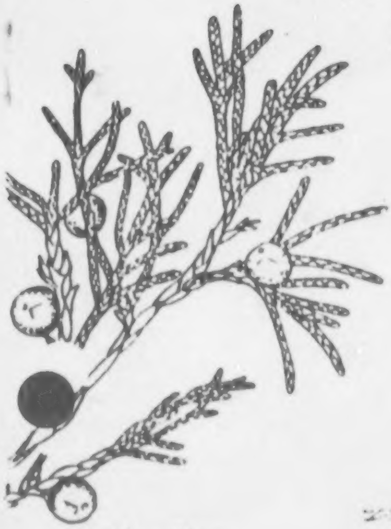
COMPOUND LEAVES

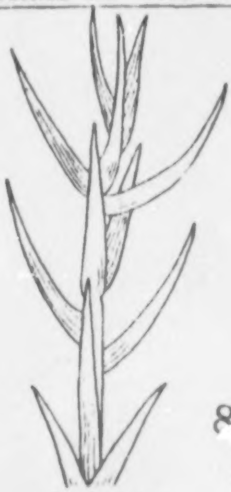

Compound

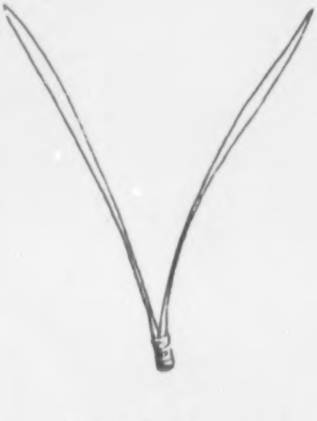

Compound


Doubly-Compound

LEAF FORMS OF THE CONIFERS


Scale-like


Awl-like


Needle-like

Holmes

845

LESSON 10: FOREST MANAGEMENT AND ASSOCIATED PROBLEMS

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define the objectives of forest management.
2. List five purposes of planting trees.
3. List six site factors to consider when planting a tree.
4. List four associated problems of forest management.
5. Define the difference between an "even-aged" timber stand and an "uneven-aged" timber stand.
6. Define when a tree is considered a merchantable product.
7. Define how many board feet an Indiana woods will grow per acre.
8. List three steps to good woods management.
9. List five pointers on farm woodlands.
10. Demonstrate how to plant hardwood seedlings.
11. Define how to manage woodlands for wildlife.
12. Demonstrate proper pruning procedures.

MOTIVATION:

1. Why is forest management important?
2. How many of you enjoy being in the woods?
3. Will there be woods in the future?
4. What would happen if there were no forest management?
5. Make a list of forest management problems.

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handouts: "Common Tree and Shrub Pests," Picture Sheet No. 3, Purdue University Cooperative Extension Service
"Timber Theft", F-68 Purdue University Cooperative Extension Service
"Management of Farm Woods," F-18 Purdue University Cooperative Extension Service
"How to Plant Hardwood Seedling," F-54 Purdue University Cooperative Extension Service
"Managing Woodlands for Wildlife," Management Series No. 3, Indiana Department of Natural Resources
"Five Pointers on Farm Woodlands," F-47 Purdue University Cooperative Extension Service

Transparency masters: "Why You Lose Money When you Graze your Woodlands"
"Recommended Care for Your Woodlands"

Film: Wildlife and Timber, Purdue A.V. Center
Man Against Fire, Purdue A.V. Center

OUTLINE:

A. The Objectives of Forest Management:

1. The objective of farm woods management is to protect and grow as many high-quality, vigorous trees of desirable kinds as the woods will support, and to properly harvest and utilize these trees without damage to the soil when they become mature.

B. Five Purposes of Planting Trees

1. Land Stabilization

2. Watershed

3. Wildlife Habitat

4. Environmental Quality

5. Economic Returns

C. Six Site Factors to Consider When Determining Where a Particular Tree Might Grow Best:

1. Soil features-texture, color, ph, slope, structure, soil depth

2. Light-shaded or opened area

3. Competition-number of other trees around

4. Insect and disease problems

5. Moisture problems-available moisture, drainage

6. Recent history of site: Fire? Sprays? Etc.

D. Four Associated Problems of Forest Management:

1. Livestock (see transparency master, "Why You Lose Money When You Graze Your Woodlands.")

2. Pests (see handout, "Common Tree and Shrubs Pests," Picture sheet No. 3)

3. Pruning (see transparency master, "Recommended Care for Your Woodlands.")

4. Timber theft (see handout, Timber Theft, F-68)

E. The Difference Between "Even-Aged" Timber Stands and "Uneven-Aged" Timber Stands: (see handout F-18, "Management of Farm Woods.")

Foresters classify timber stands into two main groups, "even-aged" stands and "uneven-aged" stands. In the even-aged stands, the trees are nearly all the same age. These stands are quite often the result of clear cutting in past years, and are most frequently found in river bottoms. The uneven-aged stands contain trees of various sizes and ages scattered throughout the woods. Most of the upland timber stands in Indiana are this type. The uneven-aged stand is best suited for annual or frequent cuts which remove defective low-value and mature trees. Quite often in the past, these uneven-aged stands have been "high-graded" which means the largest, most vigorous trees of the better species have been removed at each successive cut. This destructive practice results in leaving the cull, defective and low-value trees to make up the future stand. This type of cutting is just the reverse of good woods management.

F. A tree is of merchantable size after it reaches 12 inches at DBH (Diameter Breast Height). Consequently, the more trees over 12 inches, there are on an acre, the more merchantable growth there will be.

G. Under good management, Indiana farm woods will grow at least 200 board feet of wood per acre per year.

H. Three Steps to Good Woods Management:

1. The first requirement is complete protection from livestock of all kinds. Continued grazing destroys the woods. It is impossible to raise good trees and livestock on the same piece of ground. Livestock destroy the young seedlings thus removing future crop trees. Livestock also damage older trees by trampling, rooting, compacting the soil and opening up the stand to drying winds. Remember, that from the standpoint of good land use, there is no such thing as woods pasture.

2. Keep fire out of the woods. Fires kill timber and cause decay in the trees which are not killed. Plow and disc a "fire lane" 10 to 12 feet wide between the woods and possible sources of fire, such as railroads and highways. Keep the lane free of weeds, grass and other debris. Don't burn brush in the woods; let it rot into the soil. Show film, Man Against Fire. The story of man's fight to save forest resources from the destruction of wildfire. Shows federal, state and local cooperative fire control at work to protect the nation's water supply, timber, wildlife, recreation areas, and scenic wonders of the forests. Location-Purdue A.V. Center, Shelf No. MP0788 or MP3197.

3. Spend a few days during the year to improve the timber. One or two acres can be improved each year until the entire woods is covered. Common improvement work includes:

   a. Cut grape and ivy vines from the good trees. Vines can kill or deform trees. The vines on the poor trees, especially near the woods border, should be left for wildlife food.
   b. Girdle, cut or poison cull trees that cannot be used on the farm or sold. Taking these trees out of the woods will give other trees more room to grow.
   c. Girdle or cut ironwood, pawpaw and other species of low commercial value. Also, remove such trees of poor species since they may be overtopping better trees.
   d. Be sure that low value or undesirable trees are removed during the harvest cuts. Some of these bear large seed crops and are apt to seed into the openings made by cutting.

I. Five Pointers on Farm Woodlands (see handout F-47)

1. Keep all livestock out of the woods, permanently!

2. Prevent woods fires.

3. Cut trees wisely. Consider woods improvement and permanent timber growth.

4. Sell wisely what you can't use well at home.

5. Make timber one of your regular crops.

J. How to Plant Hardwood Seedling (see Transparency F-54)

1. Dig hole large enough to spread roots.
2. Partly fill hole and firm soil with seedling upright.
3. Add more soil and firm with foot.
4. Add loose soil as mulch.

K. How to Manage Woodlands for Wildlife:

1. See "Managing Woodlands for Wildlife," Management series No. 3, Indiana Department of Natural Resources.
2. Show film, Wildlife and Timber, 6 minutes. Portrays the interesting management relationships between wildlife and timber. How cutting timber, for instance, also improves habitat for deer, quail, and turkey. Location - Purdue A.V. Center.

TEACHING LEARNING ACTIVITIES

1. Have the students give their definition of forest management. Compare this with the objective of forest management outline part A.
2. Ask the students to give examples of the different things that we manage in a forest. (Timber, soil, wildlife, even people.) Point out that a forest has many uses and we should manage it for multiple use.
3. Discuss with the class what factors determine where a tree will grow. Make a list of the factors on the board. (See outline for assistance.)
4. Discuss the effects of placing livestock in woods. Show the transparency, "You Lose Money When You Graze Your Woodland."
5. Have the students make a collection of tree and shrub pests. Pass out Picture Sheet No. 3. Observe insect damage in woods.
6. What is the importance of pruning trees? Show the transparency, "Recommended Care for Your Woodlands."
7. Allow the class to volunteer to prune trees for the school or community.
8. Supply students with the handout, "Timber Theft", F-68. Discuss the importance of the problem and how to help solve it.

9. In what situations are trees to be planted? Have students answer this question using any available references. Point out that natural reforestation is very common in most hardwood forests. State that replanting is done on clear cut harvested, burned over, or low quality species areas or for even-aged coniferous stands. Discuss the difference between even-aged and uneven-aged timber stands.

10. Take a field trip to a managed farm woods or state-owned forest to observe the communities and growing sites or prepare slides of different growing conditions and site locations.

11. Provide copies of "How to Plant Hardwood Seedlings" and have students review the material. Demonstrate the proper procedure for planting a tree. If possible, have students set out trees. (Sources: Farm reforestation, public park, develop a school arboretum.)

12. Write on the board the question, "How is a forest managed?" Have students list their thought on the needed management practices. Remind the students that we are managing for multiple uses of the forest. Hand out information, "Five Pointers on Farm Woodlands," and see how the five suggestions compare with the list.

13. Provide the handout, "Management of the Farm Woods," for the students. Review the information of the number of trees by sizes in a well-stocked average acre. Have students make a list of wood improvement practices needed near their home on their farm.

14. Provide the pamphlet, "Managing Woodlands for Wildlife," to students for study of how wildlife should be managed. Note how management for timber and wildlife compare and differ and determine how management for both can be compatible. Show the film, Wildlife and Timber.

15. For additional activities, review the suggestions in "Management of the Farm Woods." F-18

SUGGESTED EVALUATION:

1. Assign grades to students' tree planting and pruning activities.

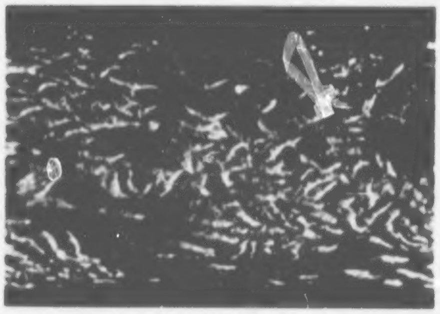
2. Quiz students on site type and tree location on field trip.

3. Provide a written exam based on the objectives and class discussions.

Picture Sheet No. 3

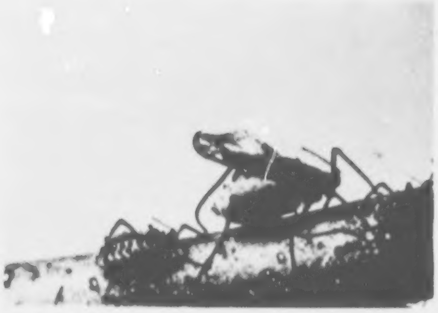
COMMON TREE AND SHRUB PESTS

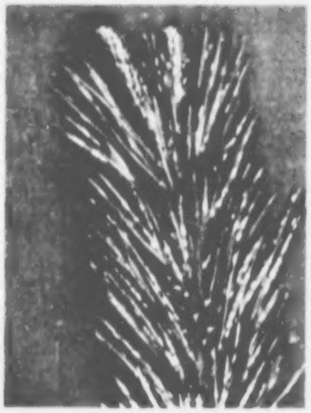
For safe and effective use of insecticides, always identify the problem correctly.

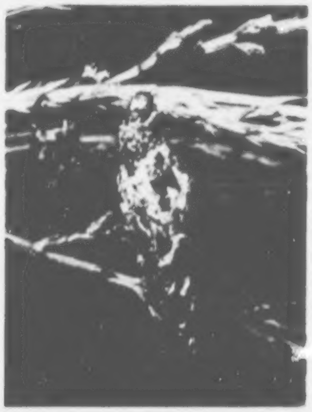

1. Oystershell scale

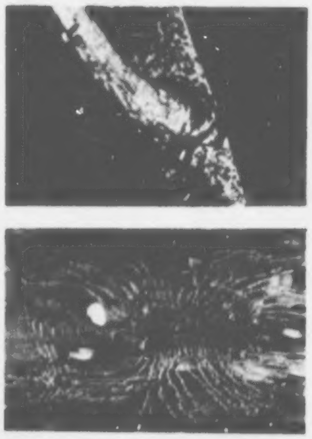
2. Maple bladder gall

3. Flatheaded borer


4. Aphid


5. Pine needle scale


6. Bagworm


7. Smaller European elm bark beetle and galleries

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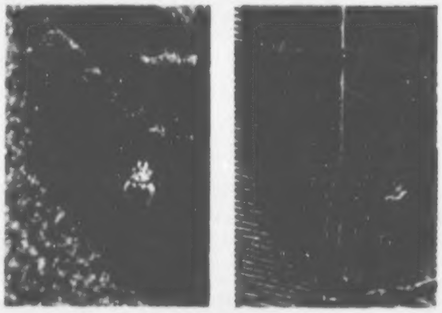
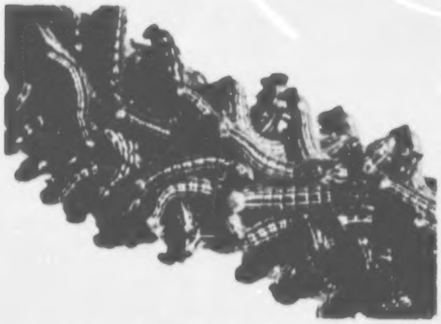

8. Elm leaf beetle and larvae

9. Eastern tent caterpillar


10. Yellow-necked caterpillar

11. Spruce mite injury

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

Purdue University
Cooperative Extension Service
Department of Entomology

Publication E-82
MAR. 1975

COMMON TREE AND SHRUB PESTS OF INDIANA

1. **OYSTERSHELL SCALE (BROWN RACE),** ***Lepidosaphes ulmi*** **(Linnaeus).** The brown race oystershell scale attacks hybrid lilac, poplar, redbud, dogwood, ash and fruit trees. The gray race type usually attacks common lilac. Mature scales are found firmly attached to the branches (pictured). Here they feed by sucking sap and may eventually kill their host. Young scales or "crawlers" wander over the plant before attaching themselves to the branches. The two-generation brown race crawlers are active in early June and late July. The gray race crawlers are present in early June only. *For control, see E-29.*

2. **MAPLE BLADDER GALL,** ***Vasates quadripedes*** **(Shimer).** The maple bladder galls appear as small, wartlike growths on the upper surface of the leaves of young silver or soft maple (pictured). They are caused by mites that overwinter in the buds and attack the leaves as soon as these buds break in spring. Although affected leaves may be distorted, the galls seldom hinder tree health and vigor. *For control, see E-56.*

3. **FLATHEADED BORER,** ***Chrysobothris femorata*** **(Olivier).** The flatheaded borer attacks many fruit and shade trees, but usually only those in a weakened, injured or sunscalded condition. Silver maple is especially susceptible. The borers burrow beneath the bark into the cambium and sapwood (pictured). If left unchecked, they may eventually girdle and kill the host. Damaged areas in the trunk may be discolored and slightly sunken. *For control, see E-41.*

4. **APHID,** ***Several species.*** Aphids attack fruit trees, shade trees, ornamental evergreens, deciduous ornamentals and many types of shrubs. They weaken their host by sucking plant sap, causing curled or twisted leaves and twigs, and malformed flowers. Some species carry virus diseases from infected to healthy plants. All types secrete "honeydew", which attracts flies and ants, stains objects and encourages growth of an unsightly sooty mold. Aphids are small, soft-bodied, winged or wingless, and vary in color from green to shades of red, black or brown (pictured). They cluster on new growth or the underside of leaves but some species work underground. *For control, see E-41.*

5. **PINE NEEDLE SCALE,** ***Phenacaspis pinifoliae*** **(Fitch).** This small, elongated, white scale attacks most types of needled evergreens but is especially common on mugho pine. Like the oystershell scale, the pine needle scale sucks sap. Heavy populations weaken the host and may kill it. This scale has two generations a year, with the young scales or "crawlers" present in late May and again in late July. *For control, see E-29.*

6. **BAGWORM,** ***Thyridopteryx ephemeraeformis*** **(Haworth).** This destructive caterpillar attacks both evergreen and deciduous plants, the most common being firs, junipers, pines, spruces, black locust, maples, sweet gum and sycamore. Starting in early June, bagworms begin feeding on the foliage, spinning a bag of thread and leaf bits as they feed and grow. Defoliation is apparent by July and August and is often fatal to evergreens. The caterpillar crawls part way out of the bag to feed (pictured), but retreats inside if disturbed. In late August or September, the mature worm attaches the bag to a branch or other object and changes into the adult stage. Eggs are contained in the overwintering bags. *For control, see E-27.*

7. **SMALLER EUROPEAN ELM BARK BEETLE,** ***Scolytus multistriatus*** **(Marsham).** This small, dark brown beetle is the principal carrier of Dutch elm disease. The larvae feed beneath the bark of dead or dying elms, creating gallaries in which they overwinter (pictured). In spring, about the time lilacs are in bloom, adult beetles emerge covered with the Dutch elm disease fungus spores. They immediately migrate to healthy trees and feed at the twig crotches (pictured), and thus may deposit the disease spores. *For control, see E-41.*

8. **ELM LEAF BEETLE,** ***Pyrrhalta luteola*** **(Muller).** The elm leaf beetle attacks all elm species but prefers Chinese elm. Both larvae and adults feed on the underside of the leaves, giving them a "skeletonized" appearance (pictured). Heavily infested leaves turn brown as if scorched by fire. Adult beetles overwinter in protected sites and can be a household pest in fall and spring. Starting about mid-May, the beetles deposit their yellow eggs on the underside of elm leaves. In a week, the eggs hatch and the new larvae feed until early July. Then they crawl or drop to the base of the tree to pupate. Adults emerge in about 10 days, feed on the leaves, and lay eggs for a second generation. *For control, see E-25.*

9. **EASTERN TENT CATERPILLAR,** ***Malacosoma americanum*** **(Fabricius).** The tent caterpillar is a leaf-feeding pest of numerous fruit trees and deciduous ornamentals. It is common on apple, wild cherry and witch hazel. It overwinters in the egg stage. These eggs are deposited in bands around the twigs. As leaves emerge in spring, the eggs hatch and larvae feed on the leaves. At night and during bad weather they custer on their silken tent (pictured). When the host plant is defoliated, the caterpillars wander about and may invade homes. *For control, see E-41.*

10. **YELLOW-NECKED CATERPILLAR,** ***Datana ministra*** **(Drury).** The yellow-necked caterpillar is found on many fruit trees and ornamentals, especially pin oak. It feeds in large colonies (pictured) on the leaves, causing greatest damage in July and August. Young caterpillars skeletonize the foliage, leaving only the veins and upper surface. The older ones eat all of the leaf but the mid-rib. *For control, see E-41.*

11. **SPRUCE MITE,** ***Oligonychus ununguis*** **(Jacot).** This tiny, spider-like pest is common to needled evergreens, including spruce, arbor vitae, hemlock, juniper and some pines. It damages the needles, causing the plant to turn white, yellow or brown. Damage occurs in early spring and usually starts at the bottom of the plant, progressing upward and outward. Close examination will reveal round, brownish eggs and an almost invisible webbing over the leaves and branches (pictured). Other species of mites attack deciduous plants. *For control, see E-42.*

Current Control Information

The information and color illustrations presented here are designed to help you correctly identify some tree and shrub pests found in Indiana. These pests and the problems they cause do not change, but the methods of dealing with them do. Therefore, Purdue University extension entomologists have prepared the following publications to keep Hoosier homeowners, nurserymen and arborists up to date on the latest recommended control methods and materials:

E-25, "The Elm Leaf Beetle"
E-27, "How to Control Bagworms"
E-29, "Scale Insects on Shade Trees and Shrubs"
E-41, "Insect Pests of Shade Trees and Shrubs"
E-42, "Mites on Ornamentals"
E-56, "Galls on Shade Trees and Shrubs"

Single copies of these publications, which are revised periodically, may be obtained by Indiana residents free of charge from their local County Extension Office or from the Mailing Room, AGAD Building, Purdue University, West Lafayette, Indiana 47907.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

4/67 (10M)

F-68
October 1976

TIMBER THEFT

A SERIOUS PROBLEM... HOW YOU CAN HELP

Prepared by the Indiana Tree Farm Committee,
Indiana Hardwood Lumberman's Association,
In Cooperation with the American Walnut-
Fine Hardwoods Association,
Cooperative Extension Service
Indiana Division of Forestry,
Indiana Farm Bureau,
Purdue University Department of Forestry
and Natural Resources,
United States Forest Service, and
United States Soil Conservation Service

TIMBER THEFT

A Serious Problem...
How You Can Help

Who are the Victims of Timber Thieves?

1. The most obvious victim is the person whose timber is stolen. Timber theft usually results in a complete loss to the owner. The "fair market value" of the stolen timber CAN NOT be written off against the federal income tax. The deductible loss is limited to the cost basis of the timber.

$

2. However, we are all victims. Timber theft discourages landowners from growing timber. This reduces timber supply and drives up the price of the many products produced from wood. Foresters report numerous cases of landowners who have sold their timber to get their money out before it is stolen. Timber should be sold when it provides the maximum benefit to the landowner, not when the owner is scared into it by thieves.

Figure 1. Walnut Price Index*

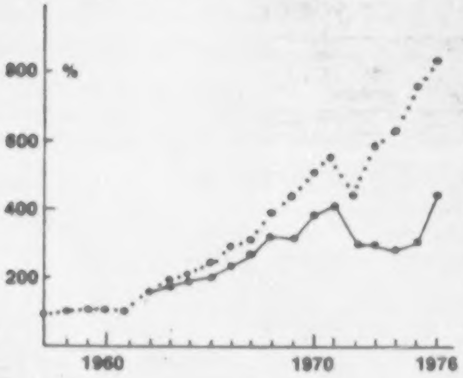
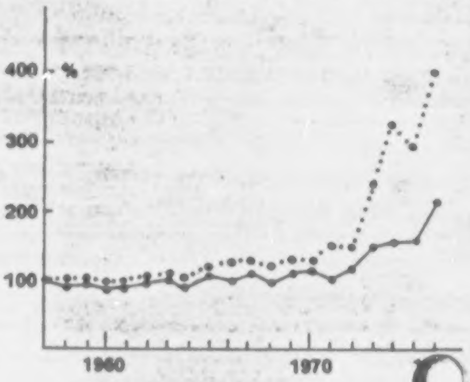


Figure 2 White Oak Price Index*



Current $ ....

Constant 1957 $ ______________________________

Why is Timber Theft a Serious Problem?

1. The value of timber, especially "high-value" trees, has increased dramatically.

   Figure 1 shows that the value of veneer quality black walnut logs has increased over 730 per cent in the last 20 years. And, Figure 2 shows that the value of veneer-quality white oak logs has increased over 300 per cent in the last 20 years.

   These rapid increases in value have resulted from increased demand for veneer quality timber by local and foreign veneer manufacturers and a limited supply of veneer-quality trees.

2. Many landowners are not aware that they own very valuable trees. These are generally black walnut or oak trees which contain large logs (18 inches or more in diameter and 8 feet or longer) with few surface defects.

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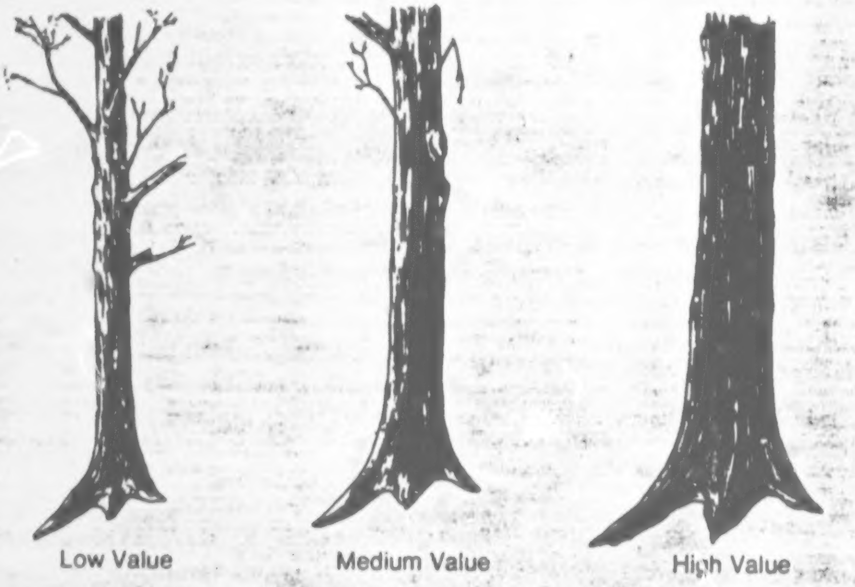
*Percentage change in price of prime veneer logs, 18 to 23 inches in diameter, delivered to a mill.



3. Although most of the thievery occurs in isolated areas, thieves have been known to take trees from the front lawns of homes. The absence of roads is not a deterrent. Thieves will cut fences and drive great distances across fields to reach their target.

4. Thieves are generally well equiped. They use chain saws modified with several mufflers and a truck with a boom loader. Although most thefts occur at night, thieves have been known to operate during daylight hours. Neighbors may see the thieves in operation but pay no attention because they think that it is a legitimate logging operation.

5. High-quality logs find a ready market. Thieves may haul logs hundreds of miles to sell them. Although members of the forest products industry usually check the source of the logs they buy, the logs may pass through several dealers before they reach the final processor. In addition, individual logs are hard to identify unless the real owner has taken the time to mark his trees.

6. Law enforcement officials report that most thefts are not discovered until several days after they occur. The logs have been sold and may be on their way to an exporter before an investigation can begin. Although the forest products industry has organized to assist the law enforcement officials, your help is also needed.

How Can You Help?

1. Locate and maintain a record of your valuable trees. The record should contain the information shown here.

Tree No.	Location	Diameter at 4.5 ft. above ground	Height to first large branch	Species
1	North pasture	10 inches	24 feet	Black Walnut
2	Yard	32 inches	30 feet	White Oak

In addition you should record any distinguishing characteristics of the bole of the tree. Better yet, stand a graduated pole beside the tree and take a picture of each side.

You can also mark your trees. If the appearance of the tree does not matter you should paint a stripe down one side of the tree. Start as high up as possible and paint all the way to the ground. Use a paint that will not wash off and make certain that it soaks into the cracks and crevices.

If appearance does matter you should mark your trees with phosphorescent paint. Use an artist's brush to apply a unique identifying mark. Keep a record of the mark used. Phosphorescent paint can be procured from Natmar, Inc., 4026 Cherry Street, Cincinnati, OH 45223, telephone: (513) 541-3010. Ask for Fantom Foil Cream No. 4. Police agencies are equiped to read these marks.

2. Join your neighbors in a cooperative protection effort. This should include the following activities:

   a. Show your neighbors the location of your valuable trees and learn the location of their valuable trees.

   b. Keep each other posted. Tell them when you will be away. Take turns patrolling the portions of your properties which are not visible from your residences.

   c. Inform each other of upcoming timber sales. Any time you hear a chain saw check it out.

   d. Make certain that your property boundaries are clearly marked. Many timber "thefts" result from misunderstandings over the location of boundaries.

3. If a theft occurs you should:

a. Record the date, time and location of the activity. If you become aware of suspicious activity obtain as much evidence as you can.

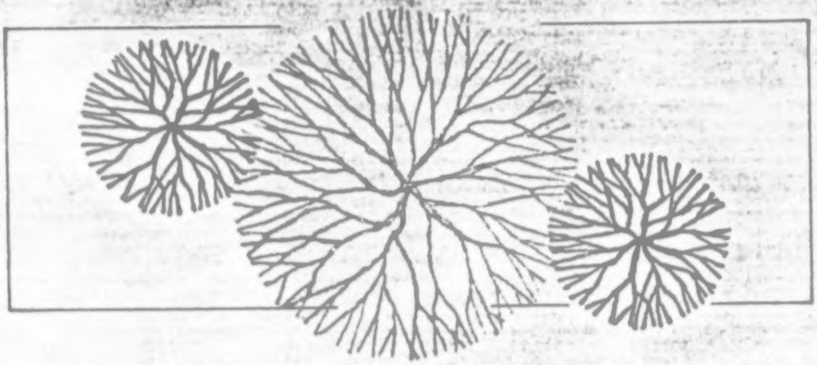
   i) Record the license numbers and descriptions of the trucks involved.

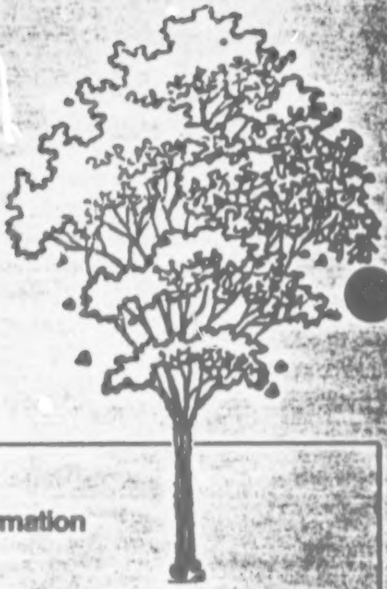
   ii) If possible get a description of the individuals.

   iii) Once you have obtained the best evidence available report the incident to the landowner and the State Police.

   The best evidence to convict a thief is eyewitness testimony.

b. Report the theft to the State Police as soon as possible. Early detection is necessary to locate the logs and obtain the identity of the seller. The State Police will call upon a cooperating member of the Indiana Hardwood Lumbermen's Association (IHLA) to assist in developing a description of the logs. It is possible to develop a description of the logs and physically match the log and stump even if the large end of the log has been cut off. This description and the circumstances of the theft will be phoned in to the Indiana Division of Forestry (317/633-6517). This information will be sent to all mills and log buyers who may be contacted by the thieves. This program has been established by the Indiana Hardwood Lumbermen's Association, the Indiana Division of Forestry, the Indiana Farm Bureau and the Cooperative Extension Service of Purdue University. Indiana and all surrounding states are included.





Where Can You Obtain Further Information or On-the-Land Assistance?

Help in identifying and scientifically managing your valuable trees is available to all private woodland owners in the state of Indiana.

Educational programs and pamphlets are available from:

Cooperative Extension Service
Department of Forestry and Natural Resources
Purdue University
West Lafayette, Indiana 47907

On-the-land technical assistance is available from:

Indiana Division of Forestry
Department of Natural Resources
613 State Office Building
Indianapolis, Indiana 46204

Professional consultant foresters are available for applying management practices in the forest, planting trees and appraising the value of trees growing or the value of those that have been damaged or stolen. A list of consultant foresters may be obtained from either the Cooperative Extension Service or the Indiana Division of Forestry.

Notes on Forestry and Wood-use

Purdue University
Cooperative Extension Service
West Lafayette, Indiana 47907

F-18

MANAGEMENT OF THE FARM WOODS

W. L. Fix and E. J. Lott
Department of Forestry and Conservation

The objective of farm woods management is to protect and grow as many high-quality, vigorous trees of desirable kinds as the woods will support, and to properly harvest and utilize these trees without damage to the soil when they become mature.

If the woods area is profitably managed, it can produce an annual crop the same as corn, wheat or soybeans. The woods differ from other crops in that the annual growth does not have to be harvested each year. Many farmers, instead of making an annual cut, let the tree growth accumulate for 3 to 5 years, or even more.

Under good management, Indiana farm woods will grow at least 200 board feet of wood per acre per year. This is equal to a tree 20 inches in diameter at a point 4 1/2 feet above the ground (diameter breast high, or D.B.H.). Growth is usually figured on all trees over 12 inches DBH, although the smaller trees which will grow into the 12-inch class during the period are also included. This is because a tree is not considered to be of merchantable size until it reaches 12 inches DBH. Consequently, the more trees over 12 inches there are on an acre, the more merchantable growth there will be, unless the trees are too crowded. Usually these trees should not be closer than 15 feet apart.

In addition to having a large number of trees, the trees should vary in size all the way from one-year-old seedlings to mature trees. When all sizes of trees are present, the cutting of the mature trees annually, or periodically, provides growing space for new seedlings and more room for the other young trees. Also, there will be other trees which will mature during the next year, or the next cutting period.

Several studies have been made to determine how many trees should be in an acre of farm woods. One study shows the following results:

RP. 10-73-2M

Cooperative Extension Work in Agriculture and Home Economics
State of Indiana, Purdue University
and the United States Department of Agriculture Cooperating
H. G. Diesslin, Director, West Lafayette, Indiana
Issued in furtherance of the Acts of May 8 and June 30, 1914.

Number of Trees by Sizes on a Well-stocked Average Acre
(Table from Soil Conservation Service Forestry Handbook)

D.B.H. (inches)	Number of Trees
4	60
6	40
8	30
10	20
12	15
14	10
16	7
18	5
20	3
22	2
24	1
26	1
Total	194

A number of Indiana studies show that the well-managed farm woods should have from 110 to 130 trees per acre 6 inches and over in diameter. Forty per cent, or about 50 of these should be more than 12 inches in DBH.

Foresters classify timber stands into two main groups, "even-aged" stands and "uneven-aged" stands. In the even-aged stands, the trees are nearly all the same age. These stands are quite often the result of clear cutting in past years and are most frequently found in river bottoms. The uneven-aged stands contain trees of various sizes and ages scattered throughout the woods. Most of the upland timber stands in Indiana are this type. The uneven-aged stand is best suited for annual or frequent cuts which remove defective, low-value and mature trees. Quite often in the past these uneven-aged stands have been "high-graded," which means the largest, most vigorous trees of the better species have been removed at each successive cut. This destructive practice results in leaving the cull, defective and low-value trees to make up the future stand. This type of cutting is just the reverse of good woods management.

A good woods is like having money in the bank. Every year it increases in value according to the rate of tree growth. This is similar to receiving interest on money in the bank. Records of farm woods in Indiana commonly show an annual return of 6 to 8 per cent interest on the capital value of the woods. This is a considerably better return than that received from the same amount of dollar capital in the bank at present interest rates.

As the woods is improved by cutting defective and low-quality trees and the careful harvesting of mature trees, the value of the annual growth of wood increases. This is because the growth is concentrated on higher quality and more valuable trees.

As you will see in F-19, not all of the profit in farm woods management is restricted to just the growth each year. The farmer can do his own logging in the woods and earn an additional $20 per thousand board feet, or more, when he sells timber.

Steps to Good Woods Management

A number of things is necessary to reach the objectives of good farm woods management. The following steps should be followed one at a time as they apply to a particular woods.

1. The first requirement is complete protection from livestock of all kinds. Continued grazing destroys the woods. It is impossible to raise good trees and livestock on the same piece of ground. Livestock destroy the young seedlings thus removing future crop trees. Livestock also damage older trees by trampling, rooting, compacting the soil and opening up the stand to drying winds. Remember, that from the standpoint of good land use, there is no such thing as woods pasture.

2. Keep fire out of the woods. Fires kill timber and cause decay in the trees which are not killed. Plow and disc a "fire lane" 10 to 12 feet wide between the woods and possible sources of fire, such as railroads and highways. Keep the lane free of weeds, grass and other debris. Don't burn brush in the woods; let it rot into the soil.

3. Spend a few days during the year to improve the timber. One or two acres can be improved each year until the entire woods is covered. Common improvement work includes:

    a. Cut grape and ivy vines from the good trees. Vines can kill or deform trees. The vines on the poor trees, especially near the woods border, should be left for wildlife food.

    b. Girdle, cut or poison cull trees that cannot be used on the farm or sold. Taking these trees out of the woods will give other trees more room to grow.

    c. Girdle or cut ironwood, pawpaw and other species of low commercial value. Also, remove such trees of poor species since they may be overtopping better trees.

    d. Be sure that low value or undesirable trees are removed during the harvest cuts. Some of these bear large seed crops and are apt to seed into the openings made by cutting.

Suggested Activities

1. Find out from your county fire warden, nearest forester or county agent how many woods burned in your county during the past year, and also the number of fires and acres burned.

2. Make a survey of your home township, and find out how many of the farm woods are at present being grazed.

3. How many classified forests are there in your county? Your county agent can help you find this information.

4. Find the names and duties of your district and county fire wardens.

5. Make a list of woods improvement practices needed in farm woods near your home or on your own farm.

References

Five Pointers on Farm Woodlands, F-47, Purdue University.

Managing the Small Forest, Farmers Bulletin 2137, U.S. Dept. of Agriculture

Further information or additional copies of this publication can be obtained through your county agent or nearest forester, or the Department of Forestry and Conservation at Purdue University, West Lafayette, Indiana 47907.

It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

Notes on Forestry and Wood-use

Purdue University
Cooperative Extension Service
Lafayette, Indiana

F-54
December 1967

HOW TO PLANT HARDWOOD SEEDLINGS

Where To Plant

Highly productive soils are essential for rapid growth of hardwoods. The best areas are deep, well-drained loams, upland areas on east- and north-facing slopes, and coves and ravines on lower slopes. Do not plant in heavy clays, on dry ridges or open eroded fields, or along fences and roadsides.

Walnut and other tap-rooted species should not be planted on shallow-soils or soils with "pans" or other restrictions to root development such as a high water table.

It might be desirable to obtain technical forestry assistance in selecting planting areas for hardwoods. Remember, the wrong choice of soil and location has been the most common cause for the failure of hardwood plantations.

Ground Preparation

Preparation of the planting area is essential for good survival and fast early growth. Where possible the soil should be plowed deep and disced several times since complete control of competing vegetation is necessary. In woodland openings and where plowing is not possible competing vegetation can be controlled by chemicals. Obtain technical assistance before using chemicals.

Plantation Care

Weed control is essential within 4 feet on either side of the planted trees for 4 years or more following planting. Weeds can be controlled with chemicals or shallow cultivation. Weed and brush competition can be further reduced by mowing the remaining area between the rows.

Protection

Remember, it is a waste of time to plant trees unless they are protected completely from fire and from all types of domestic livestock.

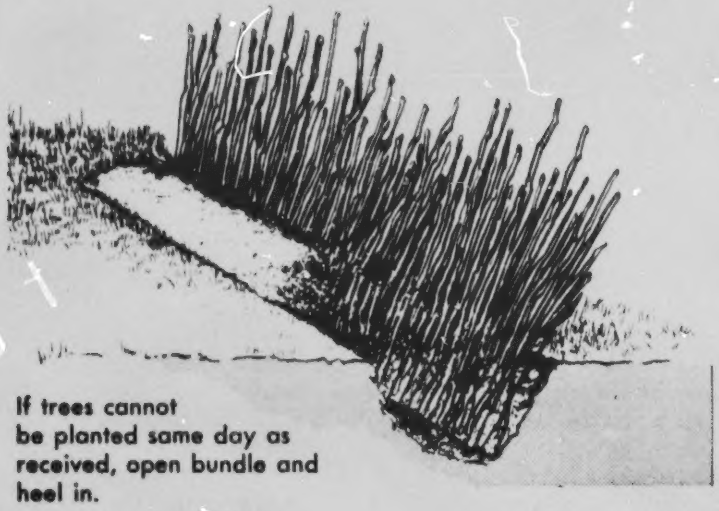
Source of Tree Planting Stock

Tree planting stock is available from state nurseries at the cost of production. Application forms are available, usually from September through March, from county Extension offices, Soil Conservation District offices, State service foresters and Extension foresters. They are also available from the State Division of Forestry, Room 607, State Office Building, Indianapolis, or the Department of Forestry and Conservation, Purdue University, Lafayette, Ind. These offices can also provide lists of commercial nurseries where tree planting stock may be purchased.

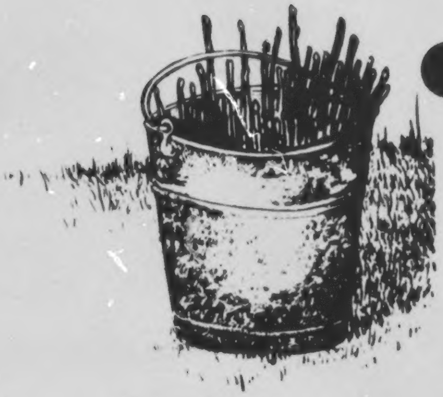
Suggested spacing	Trees per acre	Remarks
6' x 6'	1210	For black locust and erosion control plantings
8' x 8'	700	For planting in woods openings
10' x 10'	435	On good soils where trees are to be cultivated with tractors
12' x 12'	300	

865

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914.

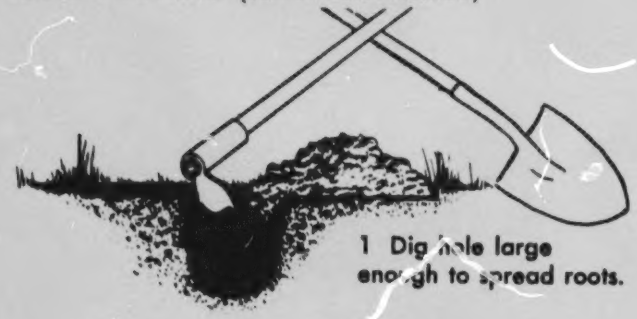


If trees cannot be planted same day as received, open bundle and heel in.

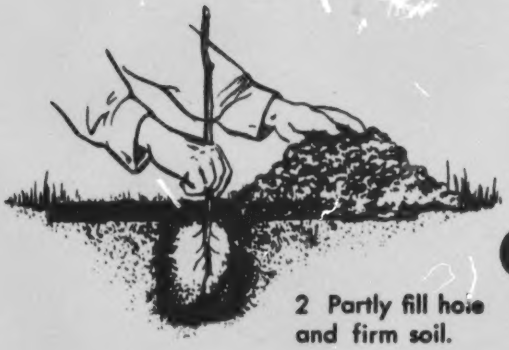


During planting keep roots moist.

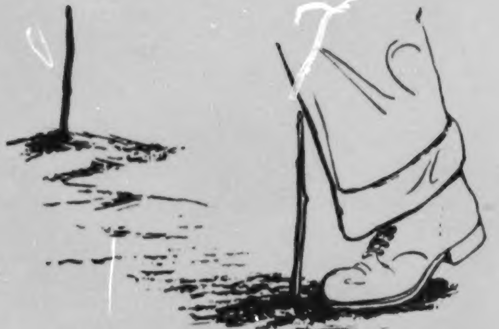
HAND PLANTING (center-hole method)



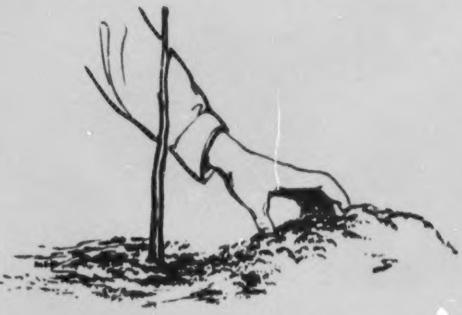
1 Dig hole large enough to spread roots.



2 Partly fill hole and firm soil.

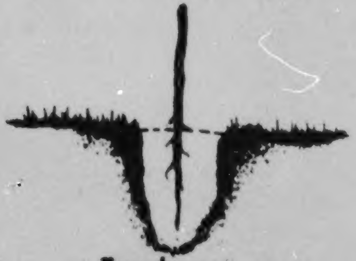


3 Add more soil and firm with foot.
Be sure the tree is upright.

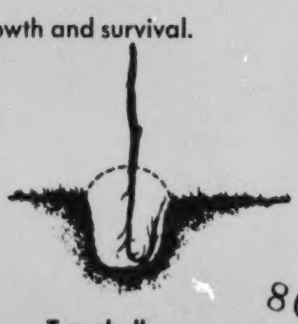


4 Add loose soil as mulch.

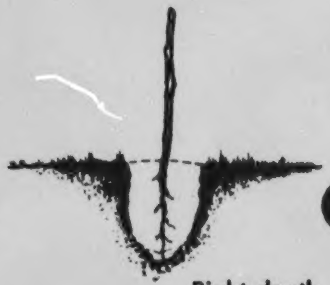
Plant to proper depth to insure optimum growth and survival.



Too deep.



Too shallow.



Right depth.

Do not root prune the seedlings.

Do not bend or cut tap roots.

TIMBER IS A GOOD FARM CROP

If wisely managed, the farm woods will produce several hundred board feet per acre per year through annual growth. This growth (similar to interest on a bank account) can be harvested annually, or periodically in the form of mature trees. For example, following is the possible harvest cutting on a 40-acre woods growing at the rate of 250 board feet per acre per year:

On an annual cutting basis:
40 acres × 250 board feet per acre per year
= 10,000 board feet (possible annual cut)

On a 5-year periodic basis:
40 acres × 250 board feet per acre per year
× 5 years = 50,000 board feet
(possible periodic cut)

A harvest program such as this for the farm woods will produce regular income on a perpetual basis and is much better than the system of slashing the woods to the ground, once in a lifetime.

Make your woods a regular crop and it will pay you well!

These five rules are just the A B C's of farm woods management.

Forestry bulletins can be found in your county Extension office.

Your county Extension agent is in close touch with foresters of the Purdue University Department of Forestry and Natural Resources where further technical assistance is available.

Cooperative Extension Work in Agriculture and Home Economics, State of Indiana, Purdue University and U. S. Department of Agriculture Cooperating. H. G. Diesslin, Director, West Lafayette, Ind. Issued in furtherance of the Acts of May 8 and June 30, 1914. It is the policy of the Cooperative Extension Service of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

F-47

FIVE POINTERS ON FARM WOODLANDS

PURDUE UNIVERSITY
Cooperative Extension Service
West Lafayette, Indiana 47907

FIVE POINTERS ON FARM WOODLANDS

Department of Forestry and Natural Resources

E. J. Lott

1. **Keep all livestock out of the woods, permanently.**
2. **Prevent woods fires.**
3. **Cut trees wisely. Consider woods improvement and permanent timber growth.**
4. **Sell wisely what you can't use at home.**
5. **Make timber one of your regular crops.**

KEEP ALL LIVESTOCK OUT OF THE WOODS

Grazing destroys the woods. You cannot raise trees and livestock on the same piece of land. A woods with no young trees has the same future as a town with no young people. Woods that are protected will grow 200 or more board feet of timber per acre each year, but a woods cannot be expected to grow forage for cattle and good timber at the same time.

Fence off a small part for shade, and keep livestock out of the rest of the woods. Classify the protected part under the Indiana Forest Land Classification Act for better protection and tax reduction.

PREVENT WOODS FIRES

Fire kills timber and causes decay in trees which are not killed outright. A good woods, unburned and ungrazed, builds up topsoil and fertility, even on steep slopes.

Plow and disc "safety strips," 10 to 12 feet wide between the woods and sources of fire such as railroads and highways. Keep these strips free of weeds and grass. Plow them on the contour in hilly ground.

Post fire warning signs, and be careful with any fire outdoors. Seek the cooperation of your neighbors and the hunters you allow on your land.

CUT TREES WISELY

Improve your woods by cutting dead, defective, crooked, or diseased trees for firewood, posts, or poles. Give the good trees a better chance. If a poorly-shaped black oak is crowding or overtopping a good white oak, cut the black oak. Cut growing vines from good, young trees.*

Dense woods borders prevent drying winds from sweeping through the woods, and provide needed cover for game birds and animals. Don't hesitate to cut trees when they are mature, but leave the woods borders thick if you want to keep the woods productive.

BE WISE IN USING OR SELLING TIMBER

Keep enough large trees of desirable species in the woods to replace a barn or other farm building. This is added building insurance at low rates.

Sell the special, high grade products to good markets when the trees are mature and when prices are right. Oak, walnut, maple, poplar, and ash are valuable in the larger sizes.

Maintain your buildings with homegrown lumber. Keep a pile of seasoned native lumber handy in your barn loft or implement shed.**

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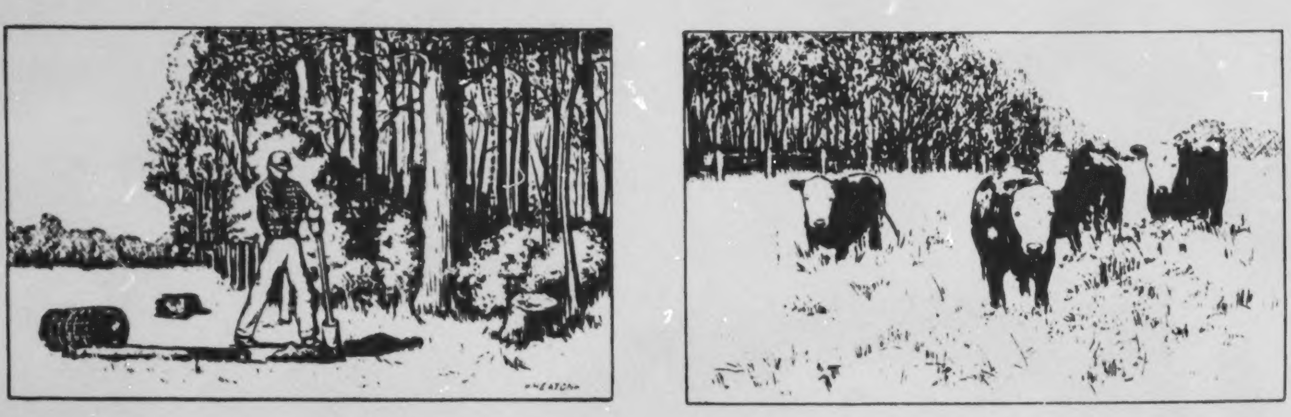
*See Purdue Extension Mimeo F-41, *Timber Stand Improvement*, available at your county Extension office.

** See Purdue Extension publication F-58 *Air Seasoning Native Hardwood Lumber*, available at your county Extension office.

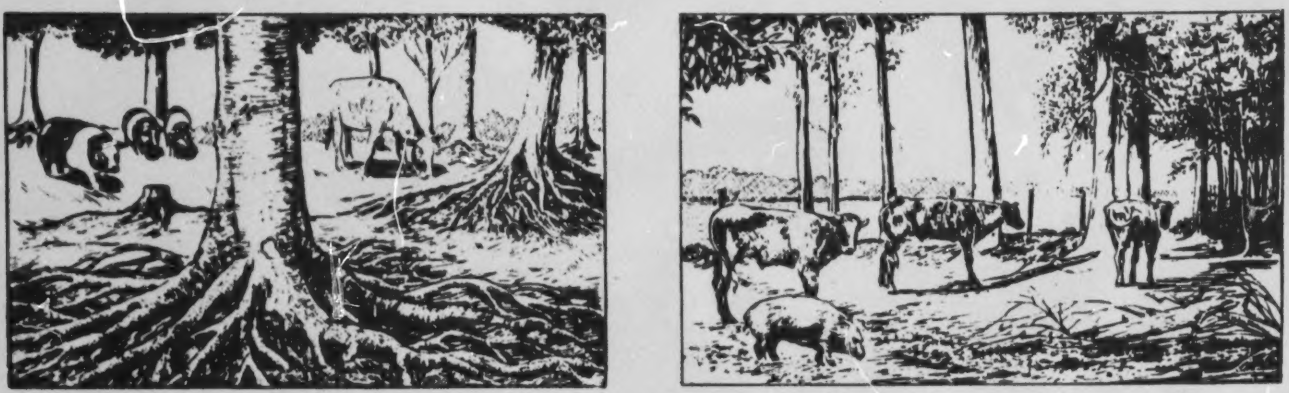
VIII-89T

Why

YOU LOSE MONEY WHEN YOU GRAZE YOUR WOODLANDS



Keep livestock in good pasture by adequate fencing.



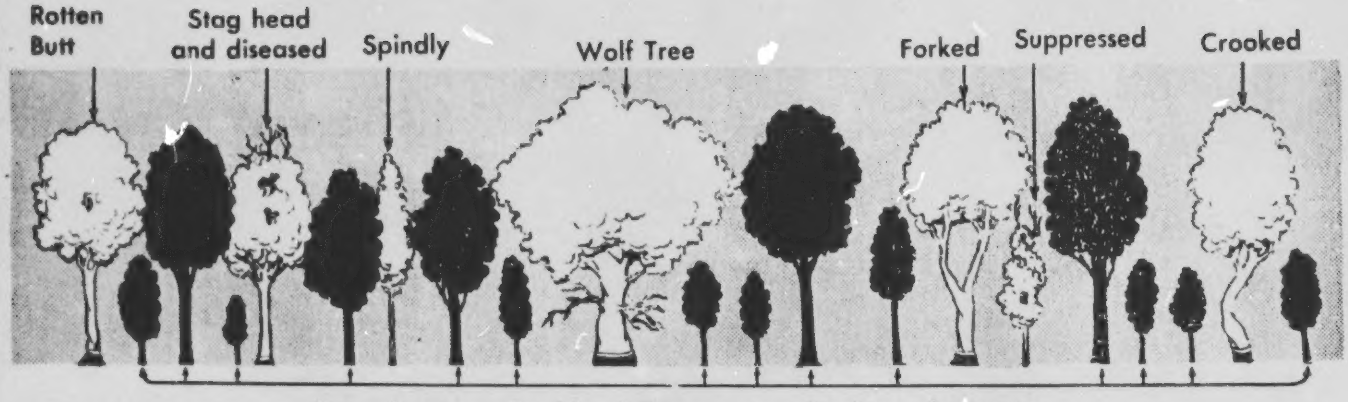
Stock in the woods, trample the roots, kill young trees, and lose weight.

Prepared and Distributed By
Division of Forestry, State of Indiana
Forest Service, U.S.D.A.
Soil Conservation Service
Agricultural Extension Service, Purdue University

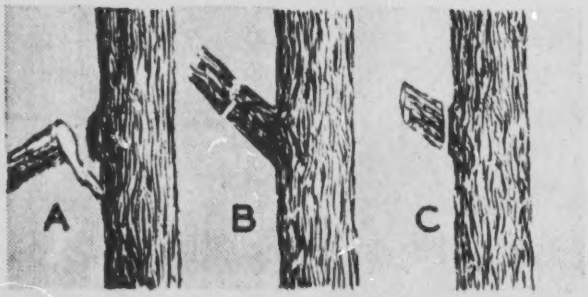
VIII-90T

Recommended

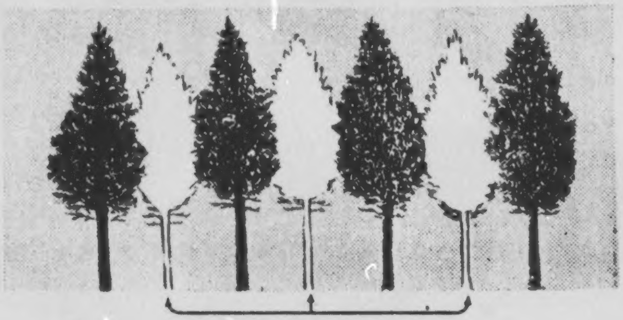
CARE FOR YOUR WOODLANDS


Rotten Butt
Stag head and diseased
Spindly
Wolf Tree
Forked
Suppressed
Crooked

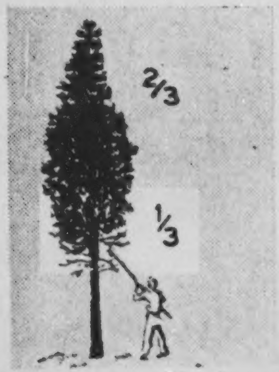
Keep the young healthy, full crown ones for future harvests.



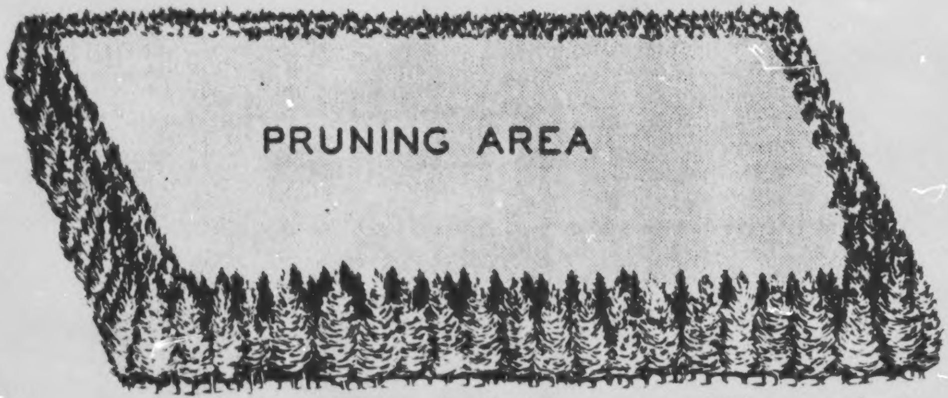
In pruning larger limbs to prevent damage (A), undercut first and then cut off limb (B), remove stub even with trunk (C).



Thin, if too close.



Prune not over ⅓ of crown.


PRUNING AREA

To prevent drying out of soil, do not prune outside rows of trees.

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Forest Service, U.S.D.A.
Soil Conservation Service
Agricultural Extension Service, Purdue University

LESSON 11: HISTORY AND IMPORTANCE OF WILDLIFE

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define wildlife.
2. Write a brief history of wildlife in Indiana.
3. List three values of wildlife and two examples of each value.
4. List five exterminated or extinct species of wildlife and five endangered species of wildlife.

MOTIVATION:

1. How would you define wildlife?
2. What is wildlife?
3. What happened to the once great herds of buffalo?
4. What happened to the once huge flocks of passenger pigeons?
5. What is it worth to you to see a bird sing, a woodpecker dig his meal from the dead branch of a tree, a flock of geese fly over, etc.?
6. Ask the students if they care about wildlife. Why?
7. Have any of the students ever tasted wild game? What kinds? When? Was it good?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handout: "A Brief History of Wildlife in Indiana"

Transparency masters: "Economics Values of Wildlife"
"Some Endangered and Exterminated Species of Wildlife"

Film: Conserving Our Wildlife Today, PUrdue A.V. Center

OUTLINE:

A. Definition - Wildlife: Wildlife includes those living things that live in the woods, prairies and streams without being directed or controlled by man.

B. History of Wildlife in Indiana (see handout):

C. Values of Wildlife:

1. Economics value.
2. Aesthetic value.
3. Food value.

Examples of Economic Values and Costs of Wildlife:

1. It is estimated that birds cut insect damage to plants by one-half billion dollars per year.
2. One scientist estimated that mature finches on one North Carolina farm ate more than 900,000 asphids (plant lice) daily during an outbreak of this pest.
3. Meadow larks in California's Sacramento Valley are thought to eat 193 tons of insects per day.
4. One ground hog eats over $50 work of alfalfa per year.
5. Transparency master, "Economic Values of Wildlife."

Examples of Aesthetic Values of Wildlife:

1. Millions of people go to zoos or to some national wildlife refuges to view mammals, birds, fishes, and other creatures that come under the classification of wildlife. (Sightseeing)
2. Some people feel hunting and fishing promote self-confidence, environmental awareness and an opportunity for privacy and contemplation.

Examples of Food Values of Wildlife:

1. Statistically, this may not amount to much more than 1 pound of wild game meat per person per year, but to some hunting families, and to some frontier citizens (Alaska for example) the freezer is the major supplement to the family food budget.
2. Wildlife preys on other wildlife. For example the major food of the Mountain Lion is Deer.

D. Endangered and Extinct Species of Wildlife:

1. Wildlife and/or game (feathered, furred, and scaled) has always been taken for granted. In the past 150 years, over 200 species of living things have been exterminated (50 have been in the United States), while over 1,000 species of wildlife are listed as "in danger of extinction."

2. See transparency master. Some exterminated and endangered species of wildlife.

TEACHING LEARNING ACTIVITIES:

1. Have the students give their definition of wildlife. Compare this with the one in the outline.
2. Discuss the history of wildlife in Indiana. Compare man's past record in dealing with wildlife to what the students expect in the future.
3. Determine how much money the class has spent on wildlife this year--included are hunting costs (guns, clothes, shells, etc.) fishing costs (poles, reels, baits, boats, etc.) photography costs, etc.
4. Discuss the fate of the pioneers if wildlife had not been available.
5. Discuss how wildlife affects the economy.
6. Discuss what a quail or pheasant might eat on your home farm. What about a bluejay, or woodpecker? What ground hog or rabbit might eat?
7. Discuss whether students believe wildlife species that are on the endangered species list (see transparency master) can yet become extinct.
8. Discuss how the students feel about the loss of extinct species of wildlife.
9. Show film, Conserving Our Wildlife Today. This motion picture attempts to show how cutting forests, draining swamps, replacing natural vegetation with crops and polluting air and water has drastically changed the amounts and kinds of governmental efforts to maintain and support wildlife. Location-Purdue A.V. Center, Shelf No. MP0939.

SUGGESTED EVALUATION:

1. Give students a quiz over the objectives.

A BRIEF HISTORY OF WILDLIFE IN INDIANA

A Pioneer Necessity

Since the earliest days of man, wild animals have played an important part in the development of civilization. Now that man has progressed from a primitive to a civilized state, he can look back and observe that wild animals have been far more helpful than harmful through the years. Without the wild animals to furnish food and clothing, it is doubtful that man could have survived at all.

Some of our ancestors, the sturdy pioneers of eastern states, found the deer of primary importance to their very existence. This is made plain through all the stories handed down in early literature concerning the occupation of that region. Deer flesh was one of the most dependable food supplies of that era, and was often the only available resource against starvation. The skins were tanned for clothing and the sinews were used for thread. Frequently, our most important figures in early American history were clad in buckskin, including the fringed hunting shirt and beaded moccasins. No other American game animals rivaled the white-tailed deer in economic value to the earliest settlers.

The American bison, commonly called buffalo, was without doubt the most important game animal to the Western American Indian. Among many of the Indian tribes, their mode of life, customs and folklore were centered about these animals. The buffalo provided food and clothing. Tepee covers were made of the skins. Tribal records of warrior hunters were described in picture writing on the smooth surfaces of the tanned skins. Tribes often moved with the migration of the American bison.

Wildlife in Early Indiana

Indiana has changed considerably since the white man first saw it. The changes that have been made by man in the forests, soil and water have affected the animals as well. Early Indiana was extensively forested with a variety of hardwood species. The pioneers found deer, bear, turkeys, ruffed grouse abundant in these forest areas. Ducks and geese were abundant in Indiana in response to the very extensive marsh areas in northwestern Indiana. The tall grass prairie areas in western Indiana had huge flocks of prairie chickens. The grey squirrel was common in this heavily wooded state but the cottontail rabbit and bobwhite quail were only limited to woods borders and burned over areas.

The Changing Years

Man has been directly responsible for the changes which have occurred in Indiana. Millions of acres of fine hardwood forests were cut and burned to make way for the plow. Ever expanding cities and industries were dependent on Indiana wood products. As the forest diminished so did the turkey. The ruffed grouse and deer populations improved as huge tracts of timber were opened but soon extensive cutting resulted in vast openings and little forest. These species were so intimately connected with the forest that they were unable to survive the clearing of the land. Increased population meant more hunting pressure, and in those years the pressure was relentless with little or no closed hunting seasons.

One of the finest waterfowl areas in the work was in the Kankakee River area of northwestern Indiana. Swamps, marshes and river oxbows hosted literally millions of waterfowl each spring and fall during migration. An extensive drainage program reduced the waterfowl habitat to a few thousand acres and waterfowl usage declined accordingly.

The fertile prairie areas of western Indiana suffered the most violent fate of all vegetation types. Intensive agriculture virtually eliminated prairie grasses and the bird and mammal species associated with this area soon disappeared or ended up as remnant populations.

As agriculture replaced forests and marshes the complexion of the animal community rapidly changed. Corn, wheat, oats, hay and weeds replaced trees and insects swarmed where forests once stood. The bobwhite quail and the cottontail rabbit liked these changes. It provided for them the kind of homes and the abundance of food which they previously lacked. For a while the prairie chicken also thrived, but as more and more of the prairie grasses were plowed under, they too had less room in which to live.

The pheasant and Hungarian partridge were introduced in Indiana in 1907 for the first time. Subsequent releases were enough to establish populations of both game birds. The change in wildlife habitat that was responsible for the loss of turkey and the prairie chicken was well suited to these foreign introductions. The pheasant never extended its range outside northern Indiana and the Hungarian partridge northeastern Indiana. Although many exotic game birds were tried, no introduced species was successful in southern Indiana.

Man's Attempt to Manipulate Wildlife

Similar changes were taking place throughout the nation. In Indiana, and other states, man came to realize that these wildlife resources were too valuable to lose. To protect them, laws were passed putting restrictions on hunting and trapping. Closed seasons were established and hunters and trappers were rationed as to numbers of animals that could be taken.

Refuges were tried next. They were created in state parks, state forests and wild game preserves. These efforts were intended to protect what was left of the former abudance of wild animals. The Indiana Department of Conservation was created to act as caretaker of these various public properties.

Artificial propogation and release of game animals was another method tried in an attempt to stem the reversal in animal numbers. Thousands of pheasants, qual, chukars, and even rabbits were raised in game farms. But the release of these animals made no real difference in game numbers. Some were harvested during hunting season but most simply fell prey to predators, weather and disease.

In the late 1930's most informed game management personnel realized that the only solution to maintaining adequate wildlife numbers was in habitat manipulation. Programs were initiated to improve wildlife habitat on private land and on state fish and game areas. Here, as in all other fields of human endeavor, new knowledge and new information are gained constantly. One fact remains, the key to wildlife numbers is in the quality and quantity of wildlife habitat.

CHART - ECONOMIC VALUE OF WILDLIFE
(1965)

TYPE OF ACTIVITY	NUMBER OF PEOPLE INVOLVED	MONEY SPENT PER YEAR	PER DAY COST	MONEY SPENT FOR
BIG GAME HUNTING	6,566,000	$64.00	$9.55	GUNS, AMMUNUNITION JACKETS, BOOTS, OTHER CLOTHING AND GEAR, FOOD, LODGING, FEES, LICENSING, GUIDES, TRANSPORTATION
SMALL GAME HUNTING	10,576,000	$58.00	$4.79	
WATERFOWL HUNTING	1,650,000	$53.00	$6.44	
BIRDWATCHING	8,196,000			FILM, SANCTUARIES, BIRD FEEDERS, FOOD, BINOCULARS, VIEWERS, CAMERAS, TOUR GUIDES, TRAVEL COSTS, MEMBERSHIPS
PHOTOGRAPHY PAINTING ETC.	3,113,000	$25.00 (EST.)	$2.00 (EST.)	

EXTERMINATED AND ENDANGERED SPECIES

EXTERMINATED

PASSENGER PIGEON
QUAGGA (SIMILAR TO A TYPE OF ZEBRA)
HEATH HEN
STELLARS SEA COW
MAURITRUS DODO
CAROLINA PARAKEET
GREAT AUK
LABRADOR DUCK
HONEY CREEPERS
PARROTS (SEVERAL TYPES)

ENDANGERED

GRAY WHALE
BLUE WHALE
GRIZZLY BEAR
TRUMPETER SWAN
TIMBER WOLF
IVORY BILLED WOODPECKER
SEA COW
CALIFORNIA CONDOR
BALD EAGLE
OSPREY
KAIBAB SQUIRREL
FLORIDA PANTHER
WHOOPING CRANE
SHORTNOSE STURGEON
PIUTE CUTTHROAT TROUT
KIRTLAND'S WARBLER
KEY DEER
SEA OTTER
LAKE STURGEON
EVERGLADE KITE
ESKIMO CURLEW
THE GRAYLING
ATTWATER'S PRAIRIE CHICKEN
BIGHORN SHEEP
ASIAN RHINOCEROS
CHEETAH
ALLIGATOR
POLAR BEAR
TASMANIAN WOLF
GIANT SABLE ANTELOPE
BANDED ANTEATER
SEA ELEPHANT

LESSON 12: WILDLIFE CLASSIFICATION

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Write a brief definition of how wildlife is classified.
2. a. List and identify from diagrams, pictures, live examples, and specimens four game birds found in Indiana.
   b. List and identify from diagrams, pictures, live examples, and specimens four unprotected birds found in Indiana.
   c. List and identify from diagrams, pictures, live examples, and specimens four game animals found in Indiana.
   d. List and identify from diagrams, pictures, live examples, and specimens four non-game animals found in Indiana.
   e. List and identify from diagrams, pictures, live examples, and specimens four fur-bearing animals found in Indiana.
   f. List and identify from diagrams, pictures, live examples, and specimens four protected birds found in Indiana.
3. Describe the reasons for classification according to game laws.
4. Describe the reasons for scientific classification of wildlife.

MOTIVATION:

1. Why is it important to classify wildlife?
2. Why are cardinals (Indiana state bird) protected?
3. Why do hunters hunt pheasant and not robins?
4. Are snakes wildlife?
5. How would the students classify wildlife?
6. Is wildlife classified the same in all 50 states?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

How to Know the Mammals, Wm. C. Brown Co.

Birds of North America, Western Publishing Co.

Transparency masters: "Some Game Birds Found in Indiana"
"Some Unprotected Birds Found in Indiana"
"Some Game Animals Found in Indiana"
"Some Non-Game Animals Found in Indiana"
"Some Fur-Bearing Animals Found in Indiana"
"Some Protected Birds Found in Indiana"
"Scientific Classification of Wolf vs. Fox"

OUTLINE:

A. How Wildlife is Classified:

1. According to game laws, wildlife is classified as game birds, unprotected birds, game animals, non-game animals, fur-bearing animals, and unprotected animals.

B. Some Important Game Birds Found in Indiana (see transparency master):

1. Pheasants
2. Quail
3. Wild turkey
4. Ruffed Grouse
5. Ducks (several kinds)
6. Geese (several kinds)

C. Some Unprotected Birds Found in Indiana (see transparency master):

1. Starlings
2. House sparrows
3. Blackbirds (can kill without permit when about to or committing damage)
4. Pigeons

D. Some Game Animals Found in Indiana (see transparency master):

1. Squirrel
2. Deer
3. Rabbit
4. Frogs

E. Some Non-Game Animals Found in Indiana (see transparency master)

1. Chipmunk
2. Ground hog
3. Moles
4. Mice
5. Rats
6. Gopher

F. Some Fur-Bearing Animals Found in Indiana (see transparency master):

1. Raccoon
2. Muskrat
3. Beaver
4. Mink
5. Red and Gray Fox

G. Some Protected Birds Found in Indiana (see transparency master):

1. Robin
2. Blue Heron
3. Cardinals
4. Bluebird
5. Meadow Lark
6. Tuffed Titmouse
7. Large numbers of birds

H. Reasons for Classifying According to Game Laws:

1. To provide protection for certain wildlife species.
2. To control harvest of game species.

I. Reasons for Scientific Classification of Wildlife:

1. To provide a common naming system that is universally recognized.
2. To provide a system based on physiologic and structural characteristics for comparison of relationships of living things.

J. Examples of Scientific Classifiction (see transparency, "Scientific Classification")

TEACHING LEARNING ACTIVITIES:

1. Ask students how they classify wildlife (follows motivation).

2. Have students make a list of wildlife that fit each classification.

3. Have students construct a bulletin board of pictures of wildlife in their proper classification. Use magazines as a source for pictures.

4. Invite a District Wildlife Biologist or State Park Naturalist to bring in specimens and present a talk on methods of identification.

5. Ask students why wildlife is classified according to game laws. Use outline to assist in discussion.

6. Ask students why the scientific classification of wildlife is important. Point out how this type of classification can be used to compare relationships of animals. See the outline for assistance to discussion. Show transparency, "Scientific Classification."

7. Take a walking trip to identify birds near the school.

8. Build and Stock a bird feeder, then observe the birds.

9. Schedule a field trip to a zoo.

SUGGESTED EVALUATION:

1. Evaluate students on their written definitions of classification.

2. Have students list examples of wildlife in the different classes.

3. If available, have students identify in writing the names of different wildlife from pictures and/or specimens.

SOME GAMEBIRDS IN INDIANA

1. RING-NECK PHEASANT
2. QUAIL
3. WILD TURKEY
4. RUFFED GROUSE
5. DUCKS (SEVERAL SPECIES)
6. GEESE (SEVERAL SPECIES)
7. OTHERS.....

SOME UNPROTECTED BIRDS IN INDIANA

1. STARLINGS

2. HOUSE SPARROWS

3. PIGEONS

4. BLACKBIRDS (CAN KILL WITHOUT PERMIT WHEN
   ABOUT TO OR COMMITTING DAMAGE)

SOME GAME ANIMALS IN INDIANA

1. FOX SQUIRREL

2. GRAY SQUIRREL

3. WHITE TAILED DEER

4. COTTONTAIL RABBIT

5. FROGS

6. OTHERS.....

SOME NON-GAME ANIMALS IN INDIANA

1. CHIPMUNK
2. GROUNDHOG
3. MOLES
4. MICE
5. RATS
6. GOPHERS
7. OTHERS.....

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SOME FUR-BEARING ANIMALS IN INDIANA

1. RACCOON

2. MUSKRAT

3. BEAVER

4. MINK

5. RED & GRAY FOX

6. OTHERS.....

SOME PROTECTED BIRDS IN INDIANA

1. ROBIN
2. BLUE HERON
3. CARDINAL
4. BLUEBIRD
5. MEADOW LARK
6. TUFFED TITMOUSE
7. OTHERS.....

SCIENTIFIC CLASSIFICATION

	Timber Wolf	Red Fox
Kingdom	Animal	Animal
Phylum	Chordata (backbone)	Chordata (backbone)
Class	Mammalia (fur bearing, milk secreting)	Mammalia (fur bearing, milk secreting)
Order	Carnivora (meat eating)	Carnivora (meat eating)
Family	Canidae (foxes, coyote, wolves, dogs)	Canidae (foxes, coyote, wolves, dogs)
Genus	Canis (wolves, coyotes, dogs)	Vulpes* (all foxes except gray fox)
Species	lupus(timber wolf)	fulva (red fox)

* Genus and species for Gray Fox is Urocyon cineroargenteus differing from the other fox genus by hair structure on the upper side of the tail.

LESSON 13: WILDLIFE MANAGEMENT

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define wildlife management.
2. List four examples of artificial homes for wildlife.
3. List five ways of managing idle lands for wildlife.
4. List six things to consider for wildlife management with herbaceous cover.
5. List three places for good wildlife management with trees and shrubs.
6. List seven ways to improve backyard wildlife management.
7. List six nuisance wildlife species and at least one way to control each.
8. List ten wildlife diseases and parasites.
9. List four examples of wildlife problems related to agriculture.
10. List ten natural problems that effect wildlife populations.
11. Write the difference between the preservationist vs. the conservationist philosophy in hunting.
12. List twelve rules of good sportsmanship.

MOTIVATION:

1. What is wildlife management?
2. Why is wildlife management important?
3. Would there be wildlife without wildlife management?
4. Do you agree with having specific hunting seasons? Why or why not?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Handouts: "Let's Help the Wood Duck", Circular No. 3, Indiana Department of Conservation, Division of Fish and Game
"Artificial Homes for Wildlife", Management Series No. 2, Indiana Department of Natural Resources
"Managing Idle Lands for Wildlife", Management Series No. 3, Indiana Department of Natural Resources
"Wildlife Management With Herbaceous Cover", Management Series No. 4, Indiana Department of Natural Resources
"Wildlife Management With Trees and Shrubs", Management Series No. 5, Indiana Department of Natural Resources
"Birds in Your Back Yard", Indiana Department of Natural Resources
"Controlling Nuisance Non-Game Wildlife", Management Series No. 9, Indiana Department of Natural Resources
"Common Wildlife Diseases and Parasites", Management Series No. 11, Indiana Department of Natural Resources
"ABC's For the Hunter"

Transparency masters: "Natural Wildlife Problems"

Film: Bobwhite Through the Year, Purdue A.V. Center

OUTLINE:

A. Wildlife Management:

Wildlife management is the science and art of changing the characteristics and interactions of habitats, wild animal populations, and men in order to achieve specific human goals by means of the wildlife resource.

B. Artificial Homes for Wildlife (two handouts):

1. Squirrel boxes.
2. Water fowl nesting structures.
3. Bird houses.
4. Artificial burrows.
5. Handout, "Let's Help the Wood Duck", Circular No. 3, Indiana Department of Conservation, Division of Fish and Game.
6. Handout, "Artificial Homes for Wildlife", Management Series No. 2, Indiana Department of Natural Resources.

C. Five Ways for Managing Idle Lands for Wildlife (Handout):

1. Fences rows and hedges.
2. Border plantings.
3. Windbreaks

4. Wet lands
5. Pond sites
6. Handout, "Managing Idle Lands for Wildlife", Management Series No. 3, Indiana Department of Natural Resources.

D. Six Things to Consider When Managing Land for Wildlife with Herbaceous Cover. (Handout)

1. Site selection
2. Site preparation
3. Fertilizing
4. Seeding
5. Types of herbaceous cover
6. Plant mixture
7. Handout, "Wildlife Management With Herbaceous Cover", Management Series No. 4, Indiana Department of Natural Resources.

E. Three Places for Good Wildlife Management With Trees and Shrubs (handout):

1. Fence row and field edge planting
2. Christmas tree plantations
3. Woods edges
4. Handout, "Wildlife Management With Trees and Shrubs", Management Series No. 5, Indiana Department of Natural Resources.

F. Seven Ways to Improve Back Yard Wildlife Management (2 handouts):

1. Provide food
2. Rearing areas
3. Travel lanes
4. Windbreaks
5. Nesting
6. Escape
7. Winter cover

8. Handout, "Back Yard Wildlife Management", Management Series No. 6, Indiana Department of Natural Resources.

9. Handout, "Birds in Your Back Yard", Indiana Department of Natural Resources.

G. Six Nuisance Wildlife Species and at Least One Way to Control Each (handout):

1. Snakes - remove their hiding places.

2. Birds - trapping, destroy nests and shooting.

3. Bats - trapping, shooting, and barriers.

4. Moles - trapping.

5. Ground squirrels (gophers) - trapping and poisoning.

6. Woodchucks (ground hogs) - gassing, shooting, trapping, and barriers.

7. Handout, "Controlling Nuisance Non-Game Wildlife", Management Series No. 9, Indiana Department of Natural Resources.

H. Ten Wildlife Diseases and Parasites (handout):

1. Botulism

2. Distemper

3. Fleas - lice

4. Lead poisoning

5. Mange

6. Rabies

7. Skin Tumors

8. Tapeworms

9. Tularemia

10. Warbles

11. Handouts, "Common Wildlife Diseases and Parasites", Management Series No. 11, Indiana Department of Natural Resources.

I. Four Examples of Wildlife Problems Related to Agriculture:

1. If you plow in the fall, the crop residues are rolled under and not available for food or ground cover through the winter.
2. If you cut the hay early you kill off thousands of pheasants and quail that could have been saved had the cutting been delayed one week.
3. If you "clean" your farm by removing brush, vines and trees from the fence rows, you deprive wildlife of protection and food.
4. If you ditch the low lands, you take away the habitat that was there for the ducks, pheasants, and many other species of wildlife that like wetness.

J. Thirteen Natural Problems That Effect Wildlife Population:

1. Starvation
2. Fire
3. Floods
4. Drought
5. Storms
6. Sleet
7. Hail
8. Snow
9. Wind
10. Heat
11. Disease
12. Parasites
13. Predation
14. See transparency master, "Natural Wildlife Problems."

K. The Difference Between the Preservationist vs. the Conservationist Philosophy on Hunting as a Wildlife Management Tool:

1. Preservationist philosophy: Each year during hunting season 15,000,000 men, women, and children kill wildlife. Unless this army is stopped the future of wildlife is indeed gloomy. If you must shoot, shoot with a camera. Mother Nature will cull her own.

2. Conservationist philosophy: The land will support only a certain population of wildlife and the excess will disappear through starvation, disease, etc. Sportsman hunting will crop some of the excess animals and allow more money to be generated for wildlife management and habitat improvement through the sale of hunting license, tax on firearms, ammunition, etc.

L. ABC's for the Hunter - see handout.

M. Rules of Good Sportsmanship:

1. Remember it's not the kill or catch but the hunt or the trip.
2. Shoot birds on the wing, not sitting. Shoot rabbits on the run. Big game should be standing still.
3. Observe gun and weapon safety rules at all times. These rules are available from the National Rifle Association (NRA) or your State Conservation Department.
4. Don't shoot game and then waste it. Clean and save. Use the meat that is taken. Consider the problem of keeping the meat fresh. (Ice, salt, etc.)
5. Keep the hunt as primitive as possible. That is, don't use all the effort savings devices that are available to you. Deliberately give yourself some handicap.
6. One must be rather close to the intended game. (On some species.) Killing range should be known by the hunter for the weapon that he is using.
7. Distant shots that merely maim or cripple game should be passed up. If you don't have a shot, don't take a shot.
8. The bow hunter should be farily close but no more than 40 yards for a heavy pull bow. (45 lbs.)
9. Duck hunters should fire when the bird is beyond 15 yards but not further than 45 yards. Any small mammal or bird when shot at too close range is blown apart and spoiled by the damage done by the pellets or bullet. This not only wastes the meat but is considered debatable sportsmanship. It's like using very heavy tackle to land light fish. It's a better test of the sportsman to use light equipment.
10. Other factors have to be considered. A high powered rifle may kill a deer 300 yards away but can the hunter see well enough at 300 yards to make sure the deer is really a deer and not a man? Can a clean kill be made or will the animal be wounded and escape into the brush?
11. One man in big game hunting party may get the shots. Up to a point, it is not unsportsmanlike to shoot for the collective bag limit of the others.

12. Educate yourself to know the laws. Get a copy of the rules and study them before you go hunting. Ask the conservation officer about the law if you don't understand it. They are there to educate the hunter as well as arrest the violator. Obey the law.

TEACHING LEARNING ACTIVITIES:

1. Have a district wildlife biologist as a guest speaker to provide information on what wildlife management is and what it entails.
2. Pass out two handouts, "Let's Help the Wood Duck", Circular No. 3, and "Artificial Homes for Wildlife", Management Series No. 2. Discuss the value of artificial homes for wildlife. Have each student build an artificial wildlife home. (This could be a source of projects for farm shop.) Let the students take their projects home and place them in a suitable area.
3. Discuss ways of managing idle lands for wildlife as they would adapt to the student's home situation. Pass out handout, "Managing Idle Lands for Wildlife", Management Series No. 3. Review handout "Managing Woodlands for Wildlife", Management Series No. 3 from Lesson 10.
4. Pass out handout, "Wildlife Management With Herbaceous Cover", Management Series No. 4. Discuss and identify types of herbaceous cover used in wildlife management. Compare different types of cover for specific sites.
5. Discuss ways for good wildlife management with trees and shrubs. Pass out and discuss handout, "Wildlife Management With Trees and Shrubs", Management Series No. 5.
6. Have the students develop a wildlife management plan for their home.
7. Have the students compare a list of nuisance wildlife species, place this list on the overhead projector and discuss how each can be controlled. Pass out and discuss handout, "Controlling Nuisance Non-Game Wildlife", Management Series No. 9.
8. Discuss how disease and parasites affect wildlife populations. Pass out handout, "Common Wildlife Diseases and Pests", Management Series No. 11.
9. Ask the students problems they've encountered with wildlife that can be related to agriculture.
10. Ask the students, "Is hunting the greatest problem related to wildlife?" Point out natural problems that contribute to fluctuations in wildlife populations.
11. Set up two groups of students, having them debate the conservationist vs. preservationist philosophy in hunting.

12. Have a conservation officer speak to the class on good hunting sportsmanship, game laws, and gun safety.

13. Finish this lesson with a field trip to observe ways and areas of good wildlife management.

14. Show the motion picture, Bob White Through the Year. This excellent film depicts the quail's dependence upon man's use of the land, the role of food, cover, weather, predators--including hunting, and other ecological factors. Location-Purdue A.V. Center, Shelf No. MP1395 or MP2433. This film is strongly recommended.

15. Conduct a weekly strip census or road census for a given location and species of wildlife over a period of one month.

16. Interview a conservation officer and determine how the annual hunting kill for a given species of wildlife is determined.

17. Under supervision of a wildlife officer catch, tag, and release a specimen of wildlife.

18. Cruise wildlife habitats and evaluate the food and cover crop conditions.

19. Interview local farmers and determine what they do to contribute to wildlife management.

20. Have the students make up their own ABC rules or reminders like the handout in this lesson.

SUGGESTED EVALUATION:

1. Give the students a quiz over the objectives.

MANAGING WOODLANDS FOR WILDLIFE

Management Series No. 3

Larry E. Lehman photo

INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
607 State Office Building
Indianapolis, Indiana 46204

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MANAGING WOODLANDS FOR WILDLIFE

by

Ed Guljas, Widlife Management Biologist

Woodlands are a remarkable resource because they are capable of being managed for multiple-use purposes. The primary goal of management should be the production of high quality timber to meet the expected increase in demand for wood products in the coming years. But at the same time the well managed woodland can also provide soil and water conservation benefits; opportunities for environmental study; photography or painting; a place to find berries or mushrooms; and very importantly, a home for wild creatures. Wild creatures furnish recreation for the hunter and those who enjoy watching animals in their natural environment.

Any woodland is capable of supporting a surprising number and variety of animals. Wildlife that use woodlands all or a portion of the year may include squirrels, deer, rabbits, raccoons, fox, woodchuck, opossum, bats, shrews, turtles, snakes, and amphibians. Several hundred species of birds are known to frequent forested areas. Typical woodland birds include woodpeckers, warblers, finches, thrushes, flycatchers, hawks, owls, vultures, bob-white quail, and in certain locations and situations, pheasant, ruffed grouse, wild turkey and even wood ducks.

Since woodlands vary greatly in size, location and plant species, the wildlife species present also vary. For example, the gray squirrel prefers extensive forest lands and is common in the large wooded tracts found in south central Indiana. They are rare in northern Indiana, however, because the majority of woodlands are typically the smaller farm woodlot variety. While deer are found in every county in the state, the likelihood of one frequenting an isolated woodlot in an intensively farmed area is remote.

Any wildlife species will only be found in an area if all or a part of the components necessary for its survival are present. These components are food, water, and shelter. Together they form the single most important key to all wildlife management—wildlife habitat. Fortunately, fully 90 percent of the woodland management needed to supply habitat requirements for a large number of wild creatures can be realized through the process of wise management for timber production. The following practices are useful in managing woodlands and have obvious benefits for wildlife.

PROTECTION

Woodland protection is an often abused conservation practice. Grazing a woods with domestic livestock will lead to the loss of trees. Trampling

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No future exists for this grazed woodlot either for timber production or for wildlife. Note the lack of ground vegetation and the exposed tree roots.

action by sharp hooves destroys feeder roots in the upper portion of the soil and affects tree growth. Soil compaction results in rainfall run-off and a lack of sub-surface moisture. On sloping ground run-off leads to soil erosion and exposes tree roots to further damage by livestock. Grazing can only result in unhealthy trees and a deterioration of timber quality and value. It eliminates nuts, fruits, young seedlings and other forest plants thereby destroying the woodland's regeneration capabilities as well as food and cover for wildlife. Grazing also prevents the perimeter or edge of the woodland from developing a thick growth of vegetation which normally occurs because of the availability of direct sunlight. With the elimination of thick edge the interior trees are more subject to storm damage and to the drying effect of the wind.

Woodland edges should be allowed to develop low growing trees and shrubs to fully protect the woodland. At the same time the shrub growth will provide a unique habitat and increase both the numbers and types of wildlife species. This is especially true for songbirds. Studies have shown that woodlands with well developed shrub edges will support up to 95 percent more birds and up to 40 percent more bird species than those without the edge development. Edges are preferred nesting sites for both game and non-game mammals and birds. Dead trees and those with cavities should always be present to provide sites for cavity nesters. Many birds take advantage of cavities and for some they are necessary for survival. Part of the reason for the decline of the eastern bluebird is a lack of suitable nesting cavities.

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Poison ivy is just one of the seemingly useless woodland plants that provide a preferred source of food to many wildlife species.

This excellent example of the type of edge possible along access lanes occurs on the Laurence VanVoorhies tree farm near North Vernon, Indiana.

In most parts of Indiana, a woodland edge would include the following beneficial wildlife plants: sumac, dogwood, sassafras and a mixture of the types of trees found in the interior—the oaks, hickories, cherries and walnuts. Along the edge could also be found the highly beneficial: green briar, poison ivy, Virginia creeper and grape; the blackberries, raspberries, grasses and a variety of other herbaceous plants. Many of these not only provide shelter and cover for ground nesting birds and mammals, but the fruits and many of the plants themselves provide food for wildlife.

Edges also provide another little considered food item—insects. Insects are especially critical to just about every species of bird as a concentrated source of protein. Protein is necessary for egg production and for the survival of the young. Abundant protein allows not only rapid growth but also serves to quickly develop wings and feathers. A rapid attainment of flight capability is a young bird's best means of avoiding predation.

Woodland protection also means keeping fires, disease and certain types of insect infestation to a minimum. This is best accomplished by the installation and maintenance of lanes or trails which allow easy access to combat any of these problems. An added benefit is access for timber harvesting. The lanes can be a definite asset to wildlife. They should be seeded to a grass-legume mixture such as orchard grass and ladino clover. Mowing once a year after the end of August when most ground nesting activity is over is a good practice. If the tree and shrub edge on either side of a lane is allowed to develop with the same plants as the woodland edge, the same benefits are introduced into the woodland interior.

This autumn olive hedge row is only three years old but is already protecting young tulip poplars and walnuts from wind damage.

SCS photo

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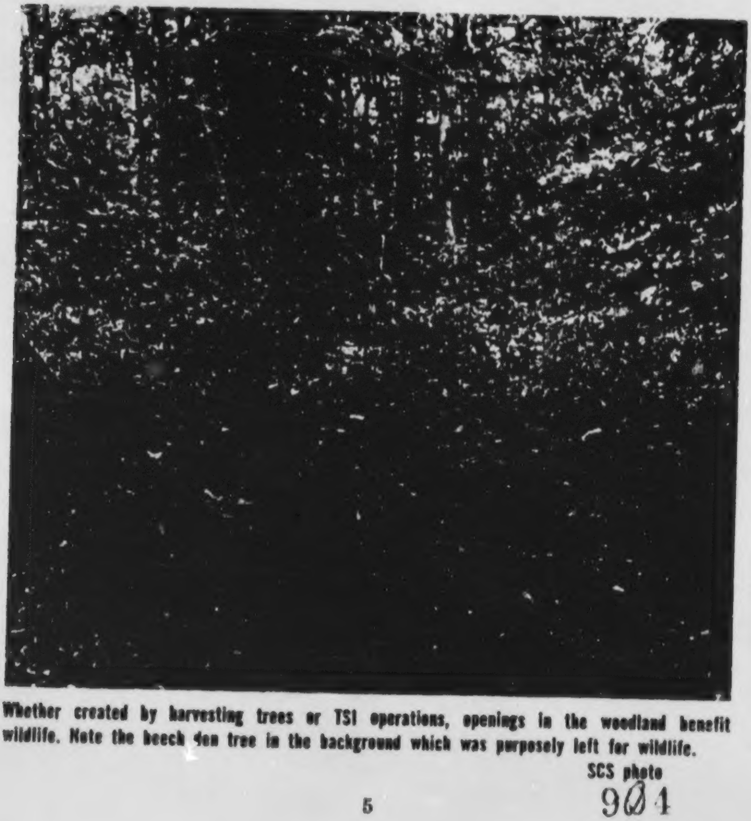
PLANTING

The establishment of trees for future woodlands benefits both the landowner and wildlife. But if seedlings are planted in an area where heavy wind occurs, they should be protected against damage. A good way to reduce the force of wind is to plant a screen to shield the young forest. A good plant material for screening is autumn olive, a sturdy and fast growing shrub. When planted in a double row it reduces wind damage by the time it is three years old. At the same time it provides cover and shelter for wildlife and serves as a travel lane or "animal road-way". Autumn olive also produces fruits which are a preferred food of song birds and other wildlife.

Pines or other conifers are often planted for Christmas tree production, field or homestead windbreaks, to combat erosion, or to rebuild the soil as a prelude to hardwood establishment in areas of previous land abuse. Regardless of primary purpose, wildlife is benefited by their presence. Their evergreen characteristic means that birds and mammals will be provided critical and often lacking winter cover. They are also used heavily by birds for nesting.



Whether created by harvesting trees or TSI operations, openings in the woodland benefit wildlife. Note the beech den tree in the background which was purposely left for wildlife.

SCS photo

HARVESTING

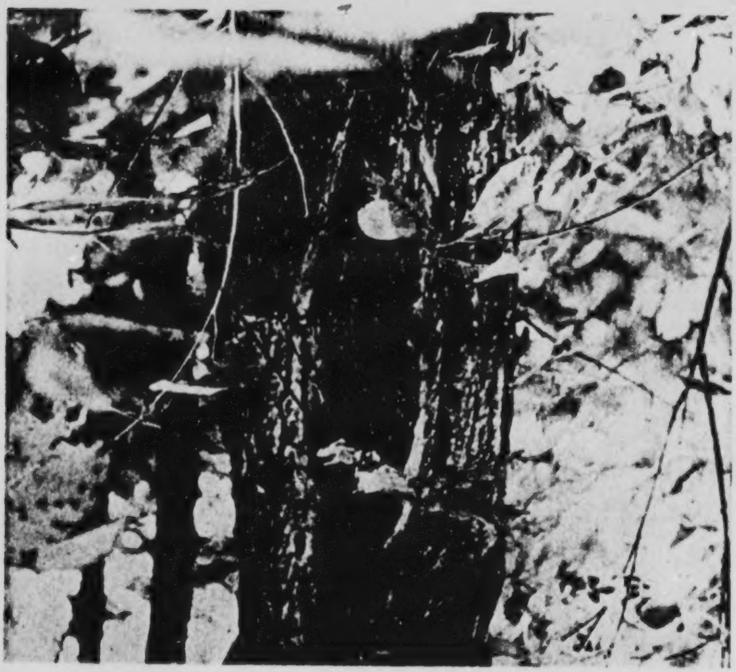
Bountiful harvests are the result of proper timber management. The reward for sound and quality timber is apparent in the settlement check. Timber harvests can also benefit wildlife. Very dense and mature timber stands on the interior of a woodland do not benefit as large a variety of wildlife species as do the edges. The bigger trees with their large, closed canopies keep the sunlight from reaching the forest floor and relatively little plant diversity is produced. Anything which eliminates this shading effect and allows the sunlight to penetrate will produce good results for wildlife. With the elimination of the canopy, grasses, seedlings, shrubs, herbaceous plants and insects will become established and more edge effect will be the result. These forest openings will continue to be beneficial until the tree seedlings grow to the point where the sun is once again excluded. By then more harvesting will probably have occurred in other areas and the edge effect will continue.

Another beneficial outcome of timber harvest is the additional wildlife shelter provided by the limbs and upper parts of the downed trees. This is especially true if trimmings are gathered into brush piles. Brush piles will persist for several years but they seldom hinder forest regeneration. Enough tree seedlings will be able to grow up through the tangle to insure the future of the woodland.

TIMBER STAND IMPROVEMENT (TSI)

Timber stand improvement is a management practice that produces good results for timber growth and aids wildlife by creating openings inside the woodland. But TSI can be harmful to wildlife. Unfortunately some people view forest plant species as being either good or bad and base their judgment entirely on economic values when doing TSI work. Trees that are marginal or poor for timber production such as sassafras, flowering dogwood, serviceberry, some cherries, or even beech and hickory are either cut down or girdled indiscriminately. Grape vines are destroyed wherever they occur, even those not growing on a potentially good timber tree. If a tree is poorly formed or hollow, little stand improvement results from eliminating a vine but the loss to wildlife is substantial. Forest plants of all types should be preserved whenever possible because they add color and variety to the woodland making it a better place to spend leisure time. In addition the food and shelter a variety of plants provide for wildlife is immeasurable.

When trees are eliminated from a timber stand it is better to girdle or frill the tree than to cut them down. This accomplishes timber management objectives and aids wildlife as well. In time insects will be attracted to the dead snag and serve as a source of food for woodpeckers and other wildlife. Cavities will form or be excavated by the woodpeckers and serve as nesting sites for a variety of birds. The snag will also be used as a "hawking site" where birds of all sorts can sit and look for insects or other prey. The dead tree will decompose and be removed gradually thereby eliminating the damage to young seedlings that a falling tree would cause.



Cavities are a habitat requirement for a good many wildlife species.

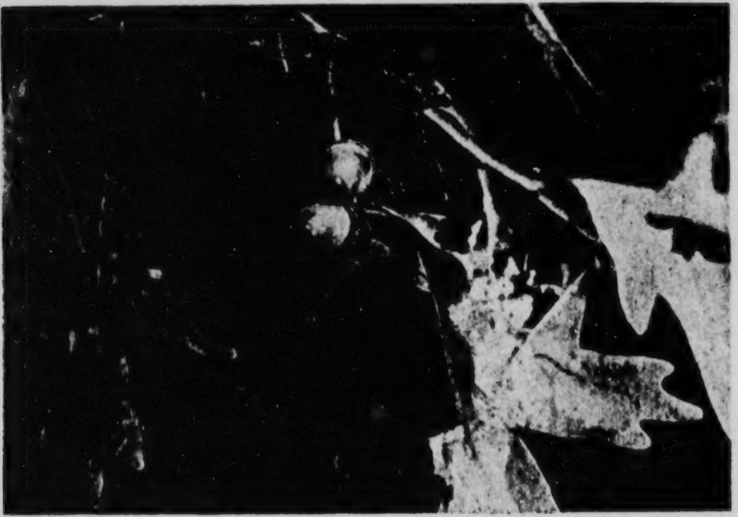
It is a wise compromise to allow food producing or den bearing trees to remain in a TSI area if we desire and appreciate the multiple benefits that a woodland is capable of providing. Hickory is an important and preferred food for squirrels and other wildlife. A large beech tree is often able to provide both denning sites and food for many wildlife species. If allowed to remain in a TSI area, den trees should not be girdled. Squirrels prefer live trees and the tree's usefulness as a home for wildlife will be shortened if killed. For maximum wildlife benefits, a minimum of two den trees per acre are needed.

TSI on the perimeter of a woodland or access lane is never good management since any timber trees encouraged on an edge will have a tendency to develop lower limbs. Large lower limbs reduce the value of saw logs since they cause knotty wood. It's advisable to allow the woods perimeter to develop naturally for a depth of 50 feet and provide the woodland protection and wildlife benefits associated with the edge.

TSI work should never be attempted without a thorough knowledge of woodland management principles. State Foresters and Consulting Foresters are available to help the private woodland owner make the most of his timber producing potential and should be contacted for advice.

GOOD WOODLOT WILDLIFE PRACTICES

In addition to those practices which insure the production of high quality saw timber, the serious landowner can employ special techniques for increasing the numbers and variety of wildlife species in his woodland.



The more acorn producing trees in a woodland, the better for wildlife.

The more mature oaks left in a wooded tract; the better for wildlife. Acorns are one of the most valuable wildlife foods. They are eaten by at least 40 mammal and 37 songbird species. They are relished by such game birds as quail, pheasant, turkey, grouse, mallard and wood duck.

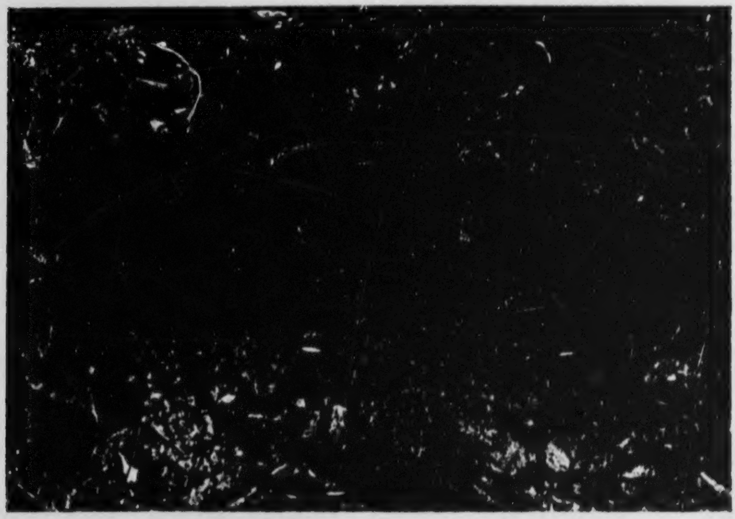
The well stocked woodland will have equal numbers of both the white and red (or black) oak groups. Contrary to previously held beliefs, wildlife do not show a preference to acorns from the white oak group. The presence of trees from both groups is an insurance against total acorn production failure due to frost or wet weather in the spring. The acorns from the red oak group take two years to develop while a single year is required for the white oak group. Unless late spring frosts occur for two successive years, the red oak group will produce when the white oak group fails. When the spring weather is good for several years in a row, both groups have the potential of providing a bumper crop of acorns and wildlife populations benefit accordingly.

There are a variety of practices that can be employed to improve the edge characteristics of the woodland in addition to allowing it to develop naturally. One of the easiest practices is to stack all loose brush, cuttings, stumps or even rocks into large piles in various locations. Another technique involves cutting all, or most of the non-fruit bearing trees in a band along a portion of the woodland perimeter. This also applies in those cases where a part of the woodland extends into a field. Allow the trees and brush to remain where they fall and the result will be a tangled mass of limbs and trunks. This will soon be invaded by grasses, vines and brambles and will provide a haven for rabbits, quail and other wildlife.

Another edge development technique involves planting conifers and flowering shrubs along the perimeter of the woodland. Good plants to use include white and red pine, autumn olive, flowering dogwood, other dogwoods, flowering crab, hawthorne or highbush cranberry. An extra benefit will result if a good ground cover is established on the outer fringe of the planting. *Sericea lespedeza* has been used extensively for this purpose and has shown excellent results.

Wildlife enhancement has great potential when croplands extend up to the edge of a woodland. The establishment of a grass-legume strip between the crops and the woods provides both food and nesting cover for wildlife. Little land is lost to the farmer since good crop yields are seldom realized next to a woods because of the shade from the trees and the competition for moisture from their roots. In addition, the farmer can use the grass-legume strip as a turn row for his machinery.

In some cases a woodland contains natural openings because of soil conditions or because of old home sites. It is highly beneficial to



Woodchuck burrows in a woodland greatly benefit ground dwelling mammals and even some birds by providing shelter in times of emergency.

maintain these in a grass-legume and shrub condition. A general rule would be to have at least 5 percent of the woodland acreage in permanent openings, either natural or man-made, for maximum wildlife benefits.

The woodland which contains a pond or a portion of a stream benefits the landowner and wildlife. Besides serving as an emergency source of water for wildlife, those species associated with a wet environment will be present to add variety and enrichment to the woodland. Ponds also serve as a source of water for the fighting of fire if it becomes necessary.

Good management may require the erection of artificial dens or nesting structures in the woodland if natural cavities are absent or in short supply. Many woodland creatues, including squirrels, wood ducks, and some hawks and owls, will take advantage of structures. Where dead trees do not exist along the edge, blue bird houses should be erected.

The woodchuck is a valuable resident of the private woodland. The burrows it digs provides homes and emergency shelter for ground living mammals and even birds on occasion. This is especially true in cases of severe winter weather. Even though they are not protected in Indiana, woodchucks should not be killed unless they are actually causing damage to crops or pasture lands.

Free information is available to the landowner who wishes to improve his woodland wildlife habitat either by planting trees, shrubs or herbaceous material, or by providing artificial nesting structures. Simply write to the Wildlife Management Section, Department of Natural Resources, 607 State Office Building, Indianapolis, 46204 and ask for literature related to your needs.

IT'S UP TO THE LANDOWNER

Woodlands can and should be managed for multiple use purposes including the enhancement of wildlife. This can easily be done, all it takes is wise judgment and the determination to make every acre produce all the benefits that result from good conservation practices.

LET'S HELP THE WOOD DUCK

By PAUL A. STEWART
Wildlife Biologist

Indiana Department of Conservation
Division of Fish and Game
605 State Office Building
Indianapolis 9, Indiana

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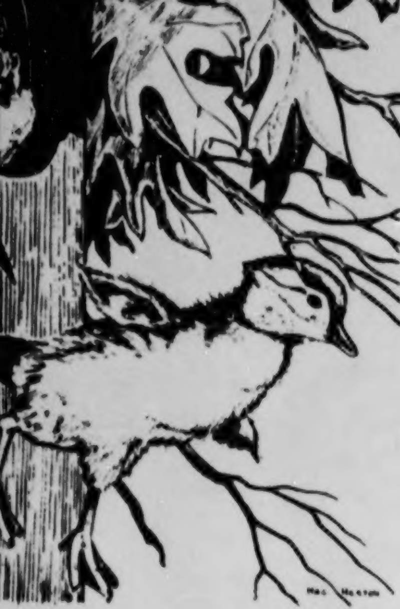

Ducklings leave the nest the day after hatching.

LET'S HELP THE WOOD DUCK

By PAUL A. STEWART
Wildlife Biologist

IN THE MORNINGS before 9 o'clock, soon after pussy willow catkins ext appear, drab female wood ducks ill be followed by their brightly lumaged mates as they fly about earching for nesting cavities among ndiana's bottomland treetops. The emale will enter the cavities as her ate waits perched on nearby limbs. f every 100 cavities examined, bout 70 will be unsuitable for wood uck nesting. Finally, a nesting cavity will be chosen, and the pair will ly away together. Frequent visits will e made to the chosen cavity during he following days or weeks before gg-laying starts in late March or arly April, depending on whether the irds have chosen to nest in the orthern or southern part of Indiana.

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NESTING PLACES.

The chosen cavity will have an entrance at least four inches wide and three inches high; the cavity will be about ten inches in diameter and from one to eight feet deep. It may be from one to 50 feet above the ground. The cavity floor will contain some loose material, such as well-rotted wood.

If the bird has been successful in finding an available natural cavity, she has made an important step toward hatching a brood of 10 to 15 ducklings. If, however, she fails to find a suitable cavity, she may resort to inspection of chimneys. If she enters several chimneys, she will likely enter one from which she is unable to escape. There will certainly be some Indiana wood ducks thus removed from the role of mother during the nest-hunting season of 1959. However, wood ducks *sometimes* successfully use chimneys with the ducklings climbing as much as six feet to escape from what often turns out to be a death trap.

NESTING SITE COMPETITORS.

The wood duck is not the only animal which uses tree cavities for nesting purposes, for similar cavities are also used by squirrels and raccoons. These animals resort to cavities not only for the protection afforded to them and their young, but also for an occasional meal of wood duck eggs. The raccoon is particularly persistent in eating wood duck eggs, and it occasionally kills and eats the incubating ducks. The gray squirrel, unlike the fox squirrel, apparently does not molest occupied wood duck nests and interferes only as a competitor for cavities.

The starling is another important competitor for a nesting place in the case of the yearling ducks which nest about four weeks later than the older ducks. Starlings can usually be discouraged from use of a cavity by repeated destruction of their nests every two or three days during the early stages of nest building. The starling sometimes builds its nest over incomplete clutches of wood duck eggs, and nest desertion by the duck then follows. After the clutch is complete or nearly so and incubation has commenced, the duck can successfully cope with disturbance from starlings.

USE OF MAN-MADE BOXES.

The fact that most areas do not have enough natural tree cavities for squirrels, raccoons, ducks, starlings and other birds, together with the fact that every incubating female wood duck and its eggs in a natural cavity is available to prying raccoons for more than four weeks, makes it apparent that available natural cavities do *not* offer everything to be desired as wood duck nesting places.

Nearly 20 years of research by federal and state governments has shown that wood ducks will readily use man-made nesting boxes and that these boxes can be made safer than natural nesting cavities. One hundred per cent utilization and 100 per cent nesting success of 18 boxes was obtained in a Pennsylvania test. Constructing and erecting nesting boxes, then, is an ideal way for boy scout groups and conservation clubs to give help to the wood duck, the most widespread and most abundant breeding duck in the Hoosier state.

CONE-TOPPED METAL BOXES.

Different types of nesting boxes have been used with varying degrees of success by different workers. Perhaps a metal box developed in Illinois, with an inverted cone roof, is the best box yet devised. Specifications for construction of this box are given in Figure 1. These metal boxes, without the mounting brackets, can be purchased for about $48 per dozen from H. Behrens Manufacturing Company, Winona, Minnesota. The bracket-mounting illustrated in Figure 1 was developed by the U. S. Fish

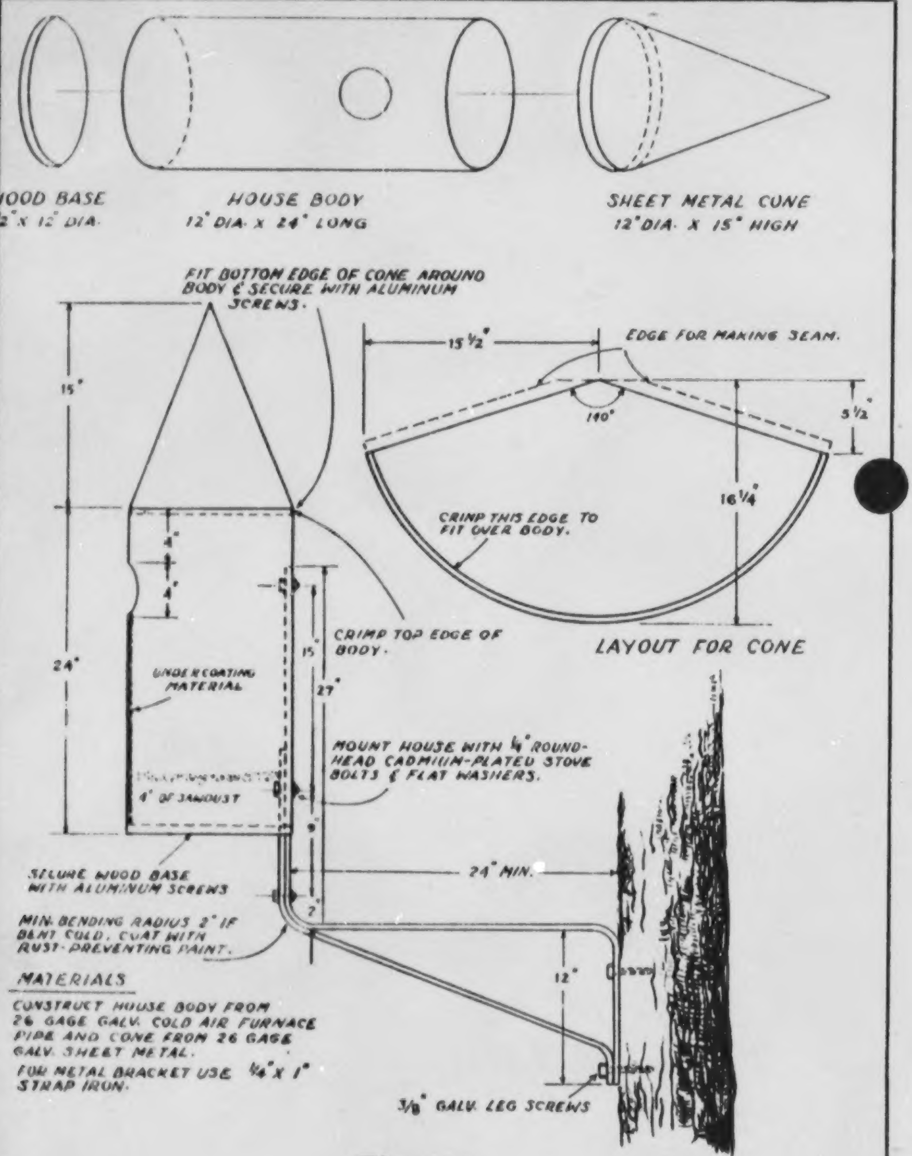
OOD BASE
2" X 12" DIA.
HOUSE BODY
12" DIA. X 24" LONG
SHEET METAL CONE
12" DIA. X 15" HIGH
FIT BOTTOM EDGE OF CONE AROUND BODY & SECURE WITH ALUMINUM SCREWS.
15"
15 1/2"
EDGE FOR MAKING SEAM.
140°
5 1/2"
16 1/4"
CRIMP THIS EDGE TO FIT OVER BODY.
LAYOUT FOR CONE
4"
4"
24"
CRIMP TOP EDGE OF BODY.
15"
27"
UNDERCOATING MATERIAL
MOUNT HOUSE WITH 1/4" ROUND-HEAD CADMIUM-PLATED STOVE BOLTS & FLAT WASHERS.
4" OF SAWDUST
9"
24" MIN.
SECURE WOOD BASE WITH ALUMINUM SCREWS
2"
MIN. BENDING RADIUS 2" IF BENT COLD. COAT WITH RUST-PREVENTING PAINT.
12"
MATERIALS
CONSTRUCT HOUSE BODY FROM 26 GAGE GALV. COLD AIR FURNACE PIPE AND CONE FROM 26 GAGE GALV. SHEET METAL.
FOR METAL BRACKET USE 1/4" X 1" STRAP IRON.
3/8" GALV. LEG SCREWS

Figure 1

METAL BOX DESIGNED TO PROTECT NESTING DUCKS FROM RACCOONS, SQUIRRELS AND SNAKES.—WITH CONE ROOF, BRACKET MOUNTING AND CYLINDRICAL BODY.

and Wildlife Service at Laurel, Maryland, and bracket-mounting is necessary to make the boxes squirrel and raccoon proof. If the box is painted, aluminum paint should be used rather than heat-absorbing green paint, for example.

ELLIPTICAL ENTRANCE WOODEN BOX.

Some persons wishing to construct rather than buy their boxes may consider a wooden box more easily made than the metal box. As an example, the elliptical entrance box illustrated in Figure 2, and also developed in Illinois, is recommended. This box does not deter squirrels, and it is raccoon-proof only in the more northern areas where raccoons are larger than in the South. In an Ohio study, this type box was used significantly more by starlings than four other types of boxes; hence it was more often unavailable to wood ducks.

Where this type of box is used, the operator should make a special effort to prevent occupancy by starlings through repeated destruction of the nests. The material for construction of these boxes can be purchased for about $1.30 per box. Rough unfinished lumber should be used, and the boxes need not be painted.

GREASE DRUM BOX.

Perhaps the cheapest usable box is made from a 100-pound grease drum such as is available from garages and service stations. Drums which have been used for gear lubricant rather than chassis lubricant are most easily cleaned. The entrance hole, water drainage holes, and holes used in mounting can be burned through the drum with an acetylene torch. This box is not raccoon-proof.

RACCOON-PROOFING THE BOXES.

Grease drum boxes seem to be raccoon-proof if the boxes are mounted on steel posts that protrude through the bottom of the box. Boxes mounted on trees and not otherwise protected can be raccoon-proofed by application around the tree trunk of a wide band of Tanglefoot, a sticky substance used for preventing insects from climbing trees. However, annual replacement of the Tanglefoot is necessary.

HELPING DUCKLINGS ESCAPE.

Because ducklings can get out of the box only by climbing its sides, it is essential that the inside of the box have a rough surface below the entrance. In the metal box, the rough surface can best be provided by smearing the inside of the front of the box with a thick layer of automobile undercoating mixed with sawdust or vermiculite. If unplaned lumber is used for the wooden boxes, no further provision for the ducklings' escape is needed.

USE OF NESTING MATERIAL.

At least four inches of sawdust or a mixture of sawdust and shavings should be placed on the bottom of the box. If loose material is omitted, boxes will ordinarily not be used by wood ducks. No nesting material other than the down from her breast will be added by the female duck. Addition of down usually starts after laying of the fourth to tenth egg. The female always covers the eggs when leaving the nest except in the case of "dump" nests — nests containing eggs never incubated by the first duck using the nest.

MOUNTING THE BOXES.

Boxes may be mounted either on trees over land or water or on posts over water. Whether the boxes are mounted on trees or posts makes little difference in utilization of the

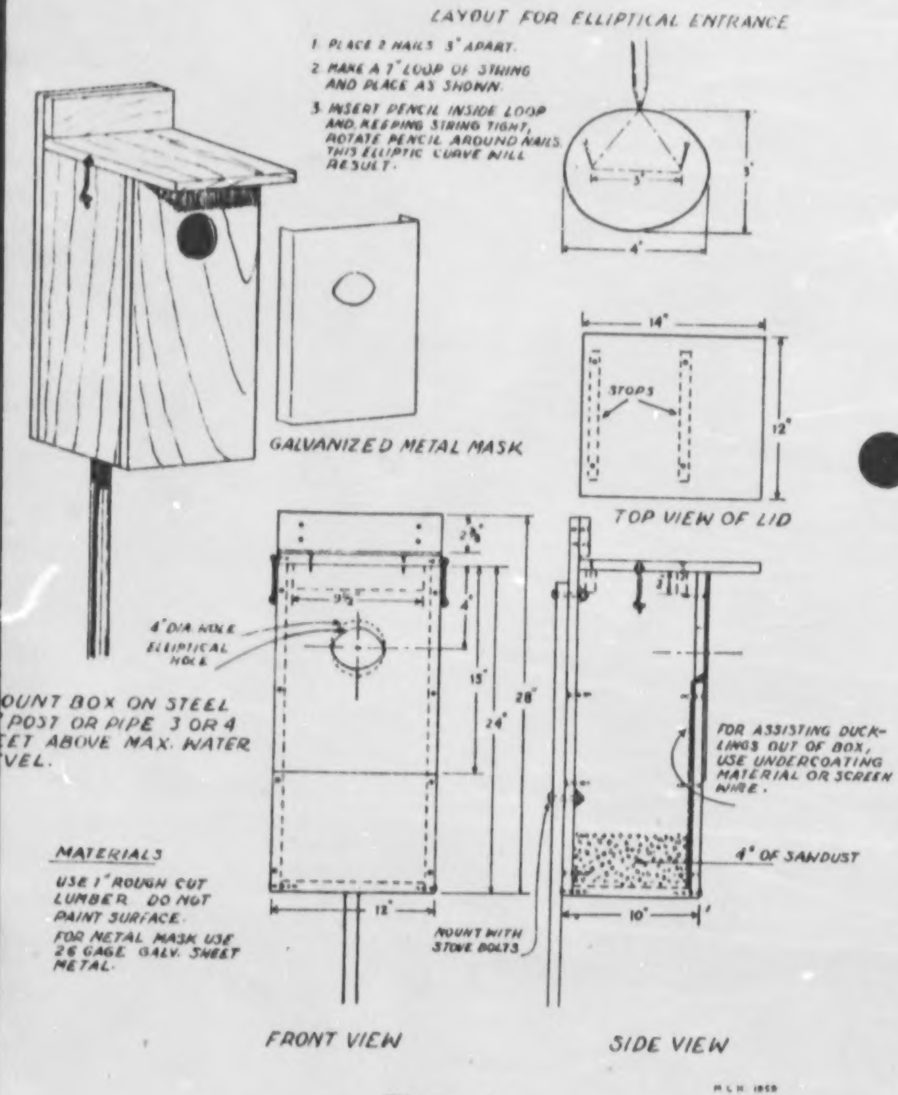
LAYOUT FOR ELLIPTICAL ENTRANCE
1 PLACE 2 NAILS 3" APART.
2 MAKE A 7" LOOP OF STRING AND PLACE AS SHOWN.
3 INSERT PENCIL INSIDE LOOP AND, KEEPING STRING TIGHT, ROTATE PENCIL AROUND NAILS. THIS ELLIPTIC CURVE WILL RESULT.
3"
3"
4"
GALVANIZED METAL MASK
14"
STOPS
12"
TOP VIEW OF LID
2⅝"
9½"
4"
15"
24"
28"
4" DIA. HOLE
ELLIPTICAL HOLE
OUNT BOX ON STEEL
POST OR PIPE 3 OR 4
ET ABOVE MAX. WATER
VEL.
MATERIALS
USE 1" ROUGH CUT LUMBER. DO NOT PAINT SURFACE.
FOR METAL MASK USE 26 GAGE GALV. SHEET METAL.
12"
MOUNT WITH STOVE BOLTS
FOR ASSISTING DUCKLINGS OUT OF BOX, USE UNDERCOATING MATERIAL OR SCREEN WIRE.
4" OF SANDUST
10"
1"
FRONT VIEW
SIDE VIEW
M.L.H. 1959

Figure 2

WOODEN BOX DESIGNED WITH METAL MASK AND ELLIPTICAL OPENING TO PROTECT NESTING DUCKS FROM RACCOONS.

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boxes offer similar protection from competition. If the boxes are mounted on trees over land, they should usually be at least 15 feet above ground to reduce vandalism. Boxes should face into an open space, preferably toward water, and should not be concealed among tree branches. If the boxes are mounted over water, they can best be erected during the winter when the water is ice-covered. Care should be taken to mount the boxes high enough to be safe from the highest possible water level. Mounting the boxes over water is feasible only in areas not subjected to wide ranges in water level and not affected by strong water currents.

Wood ducks nest by preference near others of the same species; therefore, it is desirable to place two or more boxes together. The boxes may be mounted side by side on the same post or tree, or they may be mounted on nearby posts or trees. A case has been reported where two females incubated, side by side, in the same nest.

DUCKLINGS LEAVE THE NEST.

In the forenoon of the day following hatching, the ducklings are called from the nest by the female as she sits on the ground or a tree limb beneath the nest. Rapidly in succession, or several at once, all ducklings in the brood clamber up the sides of the cavity and hop out to the water or ground beneath the nest. The female then leads the brood to the nearest water, and if the overland trek is long, many ducklings are lost in the trip. It is desirable, therefore, that the boxes be placed near water.

That plunge from the nest to the ground, 10, 20, or 50 feet below the nest, seldom if ever kills a duckling. The ducklings sometimes pause after the fall before moving away, but they seem to suffer no serious injury. The ducklings are very fluffy and light for their size, and they strike the ground with little impact. It has been computed that falling ducklings present one inch of surface area for each 3.2 grams of weight.

SERVICING THE BOXES.

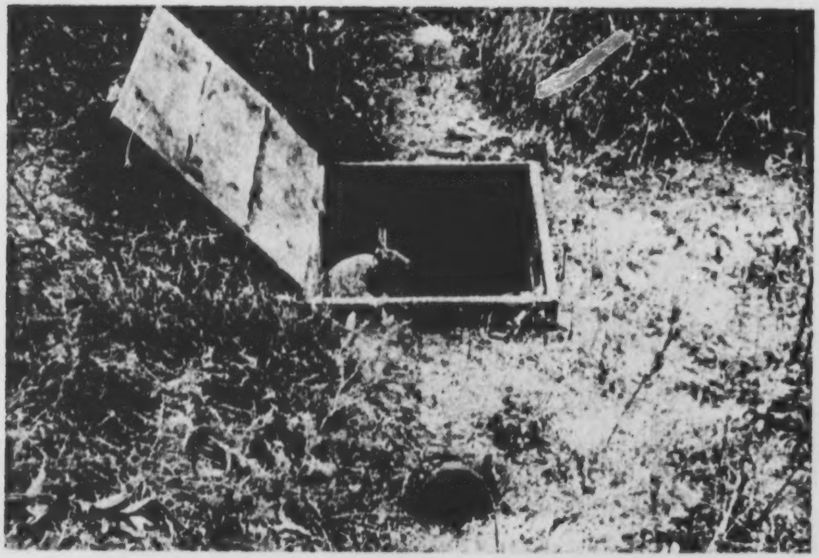
All wood duck boxes should be inspected and serviced before the nesting season. This inspection will give an opportunity to remove swarms of bees that may have moved into the boxes following the previous nesting season, and for making any needed repairs on the boxes. An early winter inspection may yield some wild honey for the family table. An additional inspection during or soon after the nesting season will give interesting information on usage of boxes and nesting success.

A PLEA FOR YOUR HELP.

Will you make a contribution toward conservation by constructing, erecting, and maintaining one predator-proof wood duck nesting box? Will you contribute toward improved hunting in the future by furnishing a safe nesting place for one female wood duck? Will you know the satisfaction of looking at an incubating wood duck in a nesting box that you have built with your own hands? The wood duck needs your help. •916

ARTIFICIAL HOMES FOR WILDLIFE

Management Series No. 2



INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
607 State Office Building
Indianapolis, Indiana 46204

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ARTIFICIAL HOMES FOR WILDLIFE

BY JOHN RUSSELL

Wildlife Management Biologist

Many species of wildlife can be attracted to the farm and suburbs by providing an artificial home.

This idea is not new. The early colonist found that American Indians stripped branches from trees and hung hollow gourds to attract purple martins. As was true with many Indian practices, the settlers copied this idea and it evolved into the aluminum martin house seen today.

It is difficult to determine exactly when man first tried to lure an animal into a cavity which was constructed with his own hands, but history suggests it was thousands of years ago. Certainly, he noticed that squirrels, raccoons, and song birds used cavities in trees that were started by woodpeckers. This observation undoubtedly led him to believe that he too could duplicate the work of the feathered wood borers.

Presently there are countless examples of wildlife using man-made structures, sometimes to the disappointment of man. Ever hear of flying squirrels in an attic, bats in a church belfry, or a skunk in the basement?

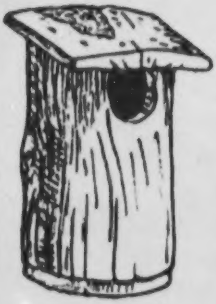
All animals need three basics to survive—food, shelter, and water. These are very broad categories. Note the varied foods that each wildlife species will eat during the year, the different sources of water utilized, and the various shelters used during the seasons.

The concern here is to provide artificial shelters. As more land is cleared and woodland destroyed, the lack of suitable cavities often limits wildlife populations.

Picture a corn field adjacent to a small stream and a stand of small trees. Abundant food and water is provided for a squirrel, but not the shelter it needs. This animal prefers tree cavities in which the temperature is a bit warmer and young can be raised. A stand of small trees usually lacks the necessary cavities. In this hypothetical case if a squirrel box were to be placed on one of the small trees, it could prove to be a very satisfactory winter home and nursery.

If everything around a farm or home is suitable for a young wildlife couple except a nesting site, a little bit of time and material can bring them to your back door. Although it is rare to find 100% success with artificial homes, 50% is a good average.

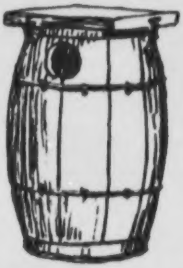
Squirrel boxes



Hollow Log Squirrel Box

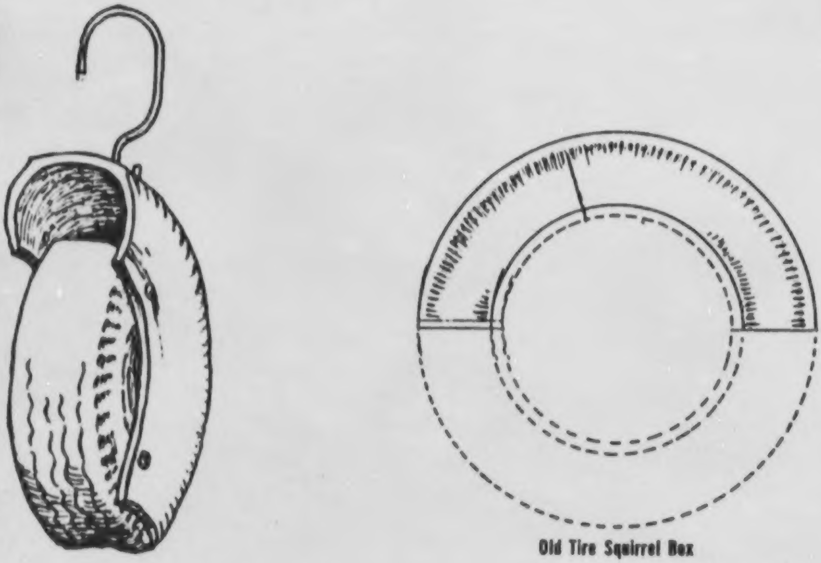
As previously mentioned, in areas where fair sized trees are found and good den trees are absent, squirrels can be readily attracted to den boxes.

A section of hollow log 16 inches long fitted with a roof and floor works well. The inside diameter should be 6 to 8 inches, and a circular entrance hole 3 inches in diameter should be cut near the top. The bottom should be hinged to facilitate cleaning.



Nail Keg Squirrel Box

Although not as natural looking as a log section, a similar den box can be made from nail kegs. Simply cut an entrance hole 3 inches in diameter and fit with a hinged top. It is important that the entrances of all type squirrel boxes be placed near the trunk of the trees to allow the animals easy access.



Old Tire Squirrel Box

Discarded automobile tires can be made into suitable squirrel dens. One tire will make two of these rather odd but very satisfactory houses.

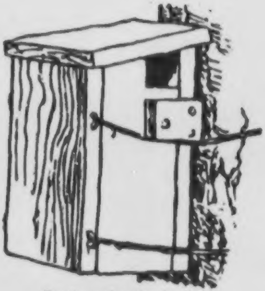
Start by sawing a tire in half and removing the beads. Then bend double allowing one end to be tucked into the other; thus exposing an entrance hole.

A half of an old tire makes an excellent squirrel nesting structure.

This will produce a fold on the side walls. It is then necessary to cut through the walls along the fold to the tread itself. The tire can then be bolted together and fitted with a hook for attachment to a tree limb.

A fourth type can be made from most lumber or plywood. This type is nothing more than a rectangular box approximately 8 inches square and 16 inches high. The roof should be sloped so that rain will run off and be hinged for an annual cleaning. The entrance, as with the other types, should be 3 inches in diameter and situated near the tree trunk.

Although the rectangular box has a definite man-made appearance, it has been used with good success in Indiana. It is best to place these in nut producing trees such as the hickories, oaks, or walnuts.



Rectangular Squirrel Box

Artificial Burrows

Ground dwellers such as rabbits, opossums, skunks, and others are attracted to subterranean boxes. These animals often depend on woodchuck burrows in the winter. Unfortunately we have little control over woodchuck abundance or their desire to dig burrows.

Here is a case where man can offer a hand by burying artificial burrows. These can be constructed from a variety of woods. Two good types are oak and

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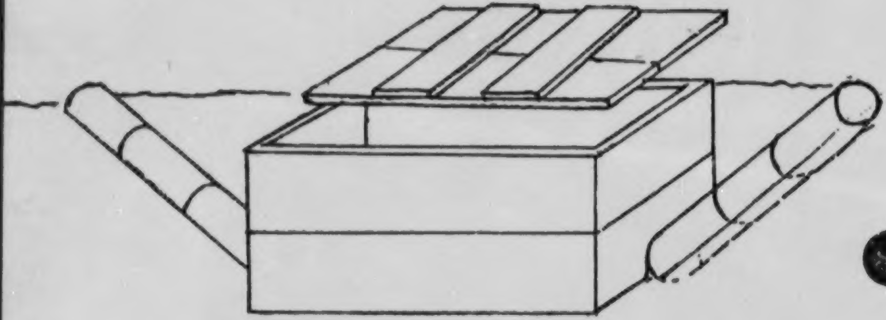
tulip. If concrete is available and one does not mind a rather permanent installation, it can be used. As with all man-made wildlife homes, it is not necessary to make them pretty to the human eye.

The dimensions of the artificial burrow are not critical as most animals could not distinguish between an 18 inch box and one which is only 17 inches. Obviously, gross errors or dimension changes could lessen the chance of a particular species using the structure.



Artificial Burrow

The artificial burrow can be an excellent substitute for woodchuck burrows. Rabbit use is most pronounced during the cold months of December to February.

Artificial burrows 18 inches by 18 inches by 12 inches high have shown good results. For the sake of durability, lumber at least ¾ inch thick should be used. Do not apply a protective coating of paint, creosote, or similar substance.

The burrows are buried at ground level with a removable top and two tile entrances at opposite ends. The top of the box (a bottom is not essential as the ground serves quite well) should be as light tight as possible. The tops can be covered with weeds or bushes to insure that the interior of the box is dark and therefore quite natural.

The entrance ways should consist of 3 or 4 field tiles (5 inch or 6 inch) buried at a about a 45° angle from the surface of the ground to the bottom of the burrows. Two semi-circles should be cut on opposite ends at the bottom of the box. These cuts should be made so that the tile will fit snugly into the box itself. The direction that the entrances face is not important.

For best usage these structures should be buried in well drained areas and near good cover such as a weedy fence row, woods border, or stream bank.

Waterfowl Nesting Structures

Although many factors can cause declining wildlife populations, loss of habitat is by far the most important. As wetlands in Indiana were drained to make room for crops, ducks and geese were lost.

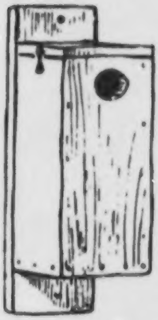
In the northern part of the state early explorers witnessed the sky darkening from waterfowl flying to and from nesting sites. Later as the settlers moved in, it was not unusual for a small hunting party to kill waterfowl by the hundreds in one day.

It was not only the loss of water and natural food which affected ducks and geese, but also the destruction of nesting sites. Homes were built around lakes; and natural vegetation was cut to make room for lawns, beaches, and boat docks. Dead trees were removed as they did not provide suitable shade.

In the past 100 years this loss of tree cavities has greatly limited the reproduction of the native wood duck. In addition to having been called the world's most beautiful bird, the wood duck is somewhat unique in that it normally nests in trees.

In most of the wood duck's range, there is competition with squirrels, raccoons, and other cavity users for suitable nesting cavities. Along many Hoosier lakes and streams the riparian habitat is good for the ducks, but the den trees are either non-existent or already occupied. This is also true with farm ponds as the birds may find the water satisfactory but are discouraged by an absence of apartments to rent. They do, however, accept nesting boxes from a variety of materials.

One of the best and easiest to construct is the rectangular box. Except for size and a few minor details, these resemble one of the squirrel boxes already mentioned. The inside dimensions should be 10 inches by 10 inches and 24 inches high. The entrance should be elliptical (egg-shaped) with the opening 3 inches high and 4 inches wide and rounded, not square cut. Like other artificial homes, either the roof or floor should be hinged to facilitate an annual cleaning.



Wood Duck Nest Box

There are two very important finishing details to insure good usage and survival of the young. About 4 inches of sawdust or similar material should be placed in the bottom of the box. Also, there should be a means for the young ducklings to climb from the bottom of the box to the entrance when they are big enough to leave the nest. A small strip of hardware cloth can be installed for the young to use as a ladder. This ladder should be a couple of inches wide extending from the bottom of the box to the entrance. Secure it with tacks or small nails flush to the inside front of the structure.

The wood duck nest box can be mounted on any large tree near a lake, pond, stream or marsh. The chance of birds using the structure is increased if it is within a few hundred feet of a body of water. It should be mounted high in the tree and fastened well away from the trunk to discourage predation. Wood ducks will use a structure mounted over water. Drive a long pipe or post into the pond bottom and mount the structure about eight to ten feet above water. The post should be predator proofed by fastening a shield about halfway to the nest box. A third of an oil drum, centered on the post will discourage animals from climbing to the nest.

Canada geese have also shown a decline in numbers, and like the wood duck they will nest in artificial homes. Although most reproduction occurs in the vast lakes and marshes of the Canadian provinces, many goslings can be reared in Indiana when suitable nesting sites (natural or artificial) are established.

The wood duck nest box can be erected in a shallow march. Note the predator shield using an old oil drum.

It had been noted that Canadas readily accept an abandoned eagle or osprey nest to raise their yearly brood. This habit undoubtedly gave man the idea that he too could provide a home for these majestic birds.

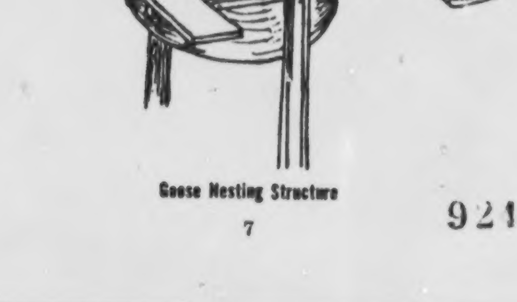
An artificial nest made from a galvanized wash tub would never win a landscaping award, but it works well for the basis of a goose nest if attention is paid to a few details. The most important of these is to select a suitable tree on which to fasten the tub. Ideally, this would be a dead snag of a tree standing in the water off shore.

The primary reason for choosing this site is that a nesting tree surrounded by water will discourage predation by animals such as mink, raccoons, dogs, and foxes. If nests are improperly located they can and do become death traps for the young.

As is often the case, one must frequently settle for something less than the ideal situation, and locating trees for goose nests is no exception. Tubs placed in trees growing along shore are satisfactory for the birds if they are placed high enough and the crown cover does not restrict easy landing and take off. These conditions can be met by cutting a few feet out of the top of the tree and securing the artificial nest there.

If shore locations are not practical, galvanized wash tubs can be erected over water by utilizing pipe, wood or steel posts. If these posts are used, it is necessary to provide the parent birds with landing facilities so they do not have to alight on a clutch of eggs when returning to the nest.

These nests can be as simple or complex as the builder wishes. One of the simplest constructions would be a 40 inch square wooden platform bolted to a post. The tub can then be mounted in the center of the platform. This platform provides a porch of several inches all around the nest. Drainage holes should then be drilled through the bottom of the tub and platform. Cut an opening about 6 inches wide to within 8 inches of the bottom of the tub. This will afford an exit for young goslings when they are ready to leave the nest.



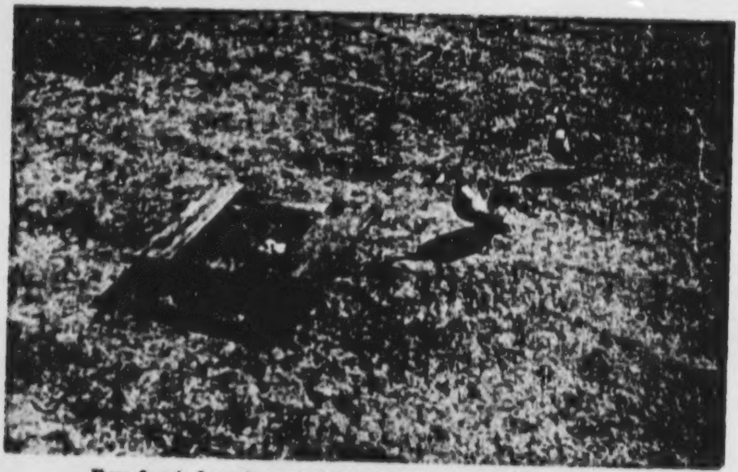
Goose Nesting Structure

The nesting structure should be from 5 to 25 feet above the water depending upon whether posts or trees are used for support. They should also be at least 200 feet apart as Canada geese, like most birds, are territorial in nature. The structure should be cleaned and filled annually with about 8 inches of hay or marsh grass.

There are many variations of construction and materials which have been used in goose nests. They have been made from wood, steel, rubber, and fiberglass. Some are designed to be elevated above the water while others are made as floating platforms.

A very successful type is made from 55 gallon drums cut into thirds. This is simply a variation of the galvanized wash tub nest.

All artificial wildlife shelters are an attempt to duplicate something already found in nature. It is not necessary for the builder to limit himself to the types mentioned but just to the original idea.



These Canada Geese have adapted their nesting to a man-made structure.

ird Houses

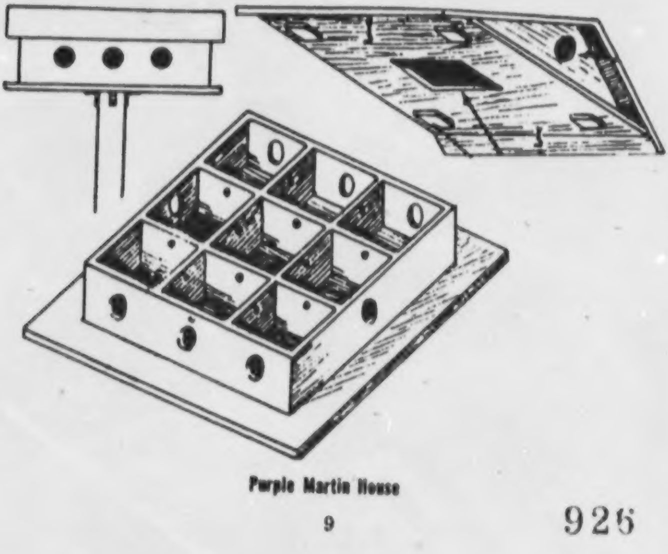
Song bird nurseries can be easily made by using a little ingenuity and imag-ation. The houses can be of the simple wooden type or they can be made of such nlikely materials as plastic bottles, tin cans, and hardware cloth.

Bird house builders are often disappointed because they erect too many houses a small area and expect all of them to be used. It should be kept in mind that ost song birds require a territory of their own. If, for instance, more than one ue bird house is erected on a small lot, the first ocupants will often prevent her bluebirds from entering their territory and using one of the other boxes. hey will, however, ignore other species of birds in their territory.

So, if any area of one acre or less is to be used for bird houses, just erect one x for the different species of birds to be attracted. If an entire farm is involved,

A simple but effective bluebird house can be made from a section of hollow log.

it would be wise to start with a few houses and add to these every year until the territories begin to overlap. When this happens, birds will prevent others of their kind from using their personal domain and some of the boxes will remain empty. Empty houses indicates that the carrying capacity of the area for that particular species is at its maximum number. Attempts at attracting more of the desired birds by erecting more houses will be futile.



Purple Martin House

Artificial homes for wildlife can be fun to build and experiment with; however, it should be remembered that all wildlife using them are prey for other animals. Try to blend the homes in with the natural surroundings and keep them drab in color whenever possible. If not done properly the young can provide an easy meal for wild and domestic predators.

With a little bit of care, artifical homes will provide years of enjoyment to people who enjoy wildlife.

Species	Floor of Cavity	Depth of Cavity	Entrance Above Floor	Dia. of Entrance
Blue Bird	5"x5"	8"	6"	1½"
Chickadee	4"x4"	8"—10"	6"—8"	1⅛"
Titmouse	4"x4"	8"—10"	6"—8"	1¼"
Nuthatches	4"x4"	8"—10"	6"—8"	1¼"
Housewren	4"x4"	6"—8"	1"—6"	⅞"
Carolina Wren	4"x4"	6"—8"	1"—6"	1⅛"
Crested Flycatcher	6"x6"	8"—10"	6"—8"	2"
Flicker	7"x7"	16"—18"	14"—16"	2½"
Red-Headed Woodpecker	6"x6"	12"—15"	9"—12"	2"
Downy Woodpecker	4"x4"	8"—10"	6"—8"	1¼"
Purple Martin	6"x6"	6"	1"	2½"
Tree Swallow	5"x5"	6"	1"—5"	1½"
Barn Owl	10"x18"	15"—18"	4"	6"
Sparrow Hawk	8"x8"	12"—15"	9"—12"	3"

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MANAGING IDLE LANDS FOR WILDLIFE

Management Series No. 3

INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
607 State Office Building
Indianapolis, Indiana 46204

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MANAGING IDLE LANDS FOR WILDLIFE

by

CHARLES DANNER

Wildlife Management Biologist

Most farms produce some wildlife. The amount depends upon the farm, but almost all farms could produce more. Increased wildlife values do not need to interfere with normal farm operations. A little management of land which is idle from current crop production will benefit the landowner with increased wildlife crops.

Wildlife is a crop of the soil. The number of animals the land can support is termed its carrying-capacity. A man who raises cattle knows his pasture will support just so many head of stock. If he tries to put more cattle into the same pasture there simply won't be enough grass for all of them. He must manage the grass with fertilizers and lime to produce more food if he wants to pasture more cattle. What he accomplishes is an increased carrying-capacity for that pasture. Wildlife is as dependent on its habitat as the cattle are on their pasture. To increase wildlife, the carrying-capacity of the land must be increased.

There is always some land on any farm which is not involved in actual crop production. Idle land, such as odd areas, fence rows, field borders, ditch banks, windbreaks, pond sites, or wetlands can be important producers of wildlife. No one farm will have all of these kinds of idle land, but almost all farms will have at least one or more kinds on which to produce wildlife.

Actually wildlife does fairly well all by itself. Their basic needs are not overly complicated, and a great deal of time, effort, and money are not needed to manage idle lands for wildlife. Most management practices are inexpensive, require only a little time and work, and in general are actually good conservation farming practices. What must be remembered is that wildlife needs food and cover and that the two need to be close together. With this thought in mind and a little work, idle lands will no longer be idle but rather excellent producers of wildlife crops.

Land Retirement Programs

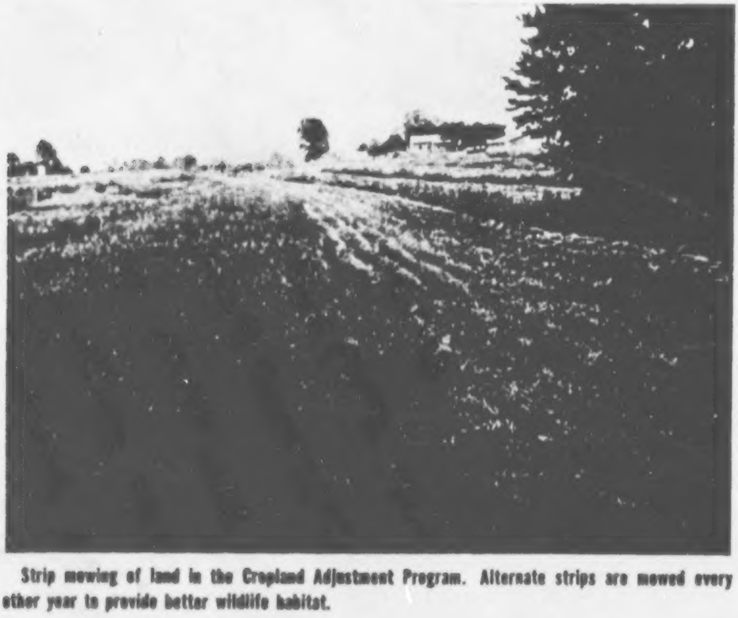
Each year there are millions of acres across the nation which are idled through federal land retirement programs. Indiana often has over a million of these acres. Such lands can often mean boom or bust for Hoosier wildlife.

The most critical need for these lands, is that they have some form of vegetative cover. Bare ground in any extensive amount is of no value to wildlife. In fact, a biological desert is created if these idle acres are denuded of vegetation.

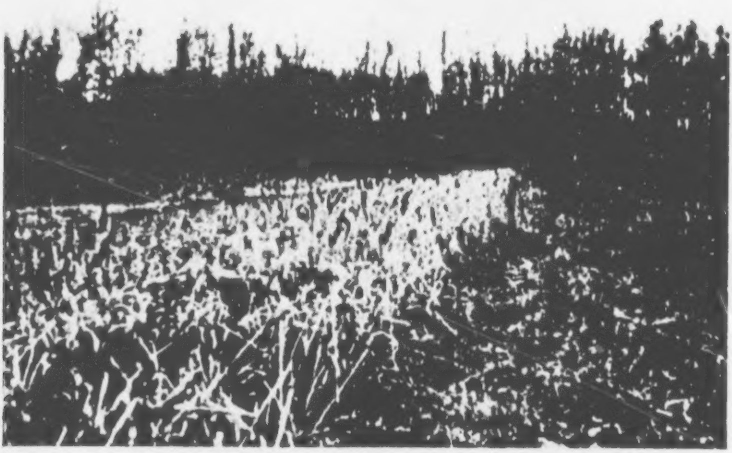
The main value of land retirement acres is spring and summer nesting cover and winter cover. A good grass-legume mixture is the best basic planting for such lands. Mowing needs to be kept to a minimum and, avoided if possible.

A grass-legume mixture is not only better wildlife management than straight grass, but helps build the soil as well. Some grasses are better for wildlife than others. Fescue is probably the poorest wildlife grass, but orchard grass, brome, or bluegrass are all good. Korean lespedeza is an excellent legume for quail, but red clover is better for rabbits. The best grass-legume mixture, however, depends on the farm and its soil.

Mowing can be an effective wildlife management tool as well as a farming operation, but it can just as easily be very detrimental to wildlife. Mowing too early in the season destroys many nests and often nesting animals. Mowing too often never allows sufficient cover to develop for the area to be of any use to wildlife. We recommend no more than a single mowing annually to maintain the grass and prevent woody encroachment. The single mowing should be delayed



Strip mowing of land in the Cropland Adjustment Program. Alternate strips are mowed every other year to provide better wildlife habitat.



Both food and cover are provided by sorghum food plots.

until the nesting season is over. Mowing operations can usually commence in the second week of August with minimal wildlife losses. However this usually results in the loss of winter wildlife cover in central and northern Indiana.

One effective wildlife mowing practice is strip mowing. Alternate strips of mown and unmown cover, each 30 to 40 feet wide, are created. The tall grasses maintain cover and the short mown grasses afford an area for many birds to hunt insects for food. The mown strips also provide excellent flushing of game animals during the hunting season. In addition, strip mowing reduces the mowing load by one half in any growing season.

One final consideration for lands idled by federal land retirement programs is the establishment of annual food plots. The Division of Fish and Wildlife gives free to any interested person 5 pound sacks of seed to plant for wildlife food plots. These food plots consist primarily of short growing sorghum and some sunflower seed and not only provide additional food supplies but excellent cover as well.

Odd Areas

Odd areas include such "waste" land as eroded areas in crop fields, bare knobs, sinkholes, sand blowouts, large gullies, abandoned roads and railroad rights-of-way, borrow pits, gravel pits, and pieces of good land that are cut off from the rest of a field by a stream, drainage ditch, or gully. Such lands can be excellent producers of wildlife.

Abandoned railroad right-of-ways can be excellent producers of wildlife.

Some odd areas already have the kinds of plants that produce good wildlife food and cover. These areas need little or no management except protection from fire and grazing. Uncontrolled fire causes much wildlife loss through nest destruction. These odd areas generally provide very little pasture and, in some cases, if pastured may cause serious erosion problems.

If the area has no food or cover plants or if natural vegetative growth needs to be speeded up, plantings may be desired. A good starting point is to plant a winter cover of adapted conifers in the center of the area. A clump of 25 to 50 should do. They need to be spaced about 8 feet apart so they will retain their lower limbs and keep good cover close to the ground as long as possible. Next, several rows of fruit producing shrubs should be planted around the conifers. Shrubs such as autumn olive, dogwoods, bush honeysuckle, wild plum, bayberry, and choke berry are all excellent. The shrubs will supply food in the fall and are useful for nesting song birds.

Working out from the shrubs, at least one half of the area should be in nesting cover for rabbits, quail, pheasant and other ground nesting animals. If native grasses are scarce, a good grass-legume mixture can be sown. One half of the grassy area should be mown every other year to keep out the woody plants.

Fence Rows and Hedges

The invention of the barbed- and woven-wire fences has been a boon to the farmer. Unless he allows native shrubs and grasses to grow in it, however, it is of no value for wildlife. The old ideas about maintaining "clean" fences in order to control insect pests or weeds are rapidly being proven false. Now studies of wildlife relationships

Good fencerows provide a "travel lane" for many wildlife species.

have shown that shrubby fence rows have many advantages for the farmer.

Shrubby fence rows have been shown to harbor fewer harmful and many more beneficial kinds of wildlife and insects than do grassy fence rows.

Hedges and shrubby fence rows fit best where fence lines will not be changed. Good locations for such fence rows are between cropland and pasture, along property boundaries and streams, or around large gullies, ponds, and odd areas.

Living fences are excellent producers of wildlife. Multiflora rose is an outstanding shrub for use in fence rows. It is capable of forming a living fence that requires no wire and no trimming or pruning. It may spread into pasture, woods, or abandoned farmland, however, and is therefore unacceptable in some areas. Where multiflora rose is not wanted, the following shrubs will produce good hedge or fence row cover without the spreading problem: red cedar, gray dogwood, choke berry, or autumn olive.

If shrubs are not desired in the fence row, the fence can still be improved for wildlife with plantings of sericea lespedeza or sweet clover. Both plants produce excellent cover and some food for wildlife.

Border Plantings

Border plantings are usually established as turnovers along the edges of cropland fields, in sapped areas such as cropland next to woodlands along stream or ditch banks, around waterways, wet spots,

A grass-legume border planting provides valuable wildlife nesting cover.

or gullies. Such plantings not only make use of narrow strips of land where satisfactory grain crops are hard to grow, but assists in the control of erosion as well.

There are really two types of border plantings useful to wildlife. One kind is made up of grasses and legumes while the other is of shrubs or shrubs and conifers. Grass-legume borders make farming easier by providing a strip on which to turn farm machinery. Shrubs or shrub-conifer borders protect woodland from drying winds and prevent the loss of leaf mulch. This helps to conserve moisture and stimulates faster tree growth.

Both kinds of border plantings benefit useful wildlife by providing either food or cover and sometimes both. The cover they furnish is next to cropland where food is usually available, and the food they produce is often next to woodland where there is cover. In addition, their cover provides excellent travel lanes for many animals.

One excellent legume for border plantings is sericea lespedeza. It is excellent cover for quail, rabbits, and many other kinds of wildlife. It does supply some food for quail. It is a perennial legume that needs to be sown only once. Sericea frequently makes a slow start, and what appears to be a seeding failure may make a good stand if left undisturbed until the second or third year. Sericea normally grows best in central and southern Indiana.

Good shrubs for wildlife borders include bush honeysuckle, gray or silky dogwood, American hazelnut, autumn olive, or wild plum. In addition to the planted shrubs, native shrubs can often be encouraged, especially along woods. Good wildlife borders can be accomplished

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Sericea lespedeza is used as a border planting material and [illegible] exceptionally well in southern Indiana.

along woodland by cutting all trees in a 30 foot strip bordering on cropland, pasture, or roads through the woodlands. The new shoots from the stumps make good deer browse. The native shrubs favored by the increased light from cutting back the trees will produce food and brushy cover for rabbits, quail, ruffed grouse, and many other kinds of wildlife.

Windbreaks

Field windbreaks are generally planted to help control wind erosion and lessen the drying effect of wind on the soil. Farmstead windbreaks are planted around farm buildings to protect them from winter and snow.

Because of the large amount of "edge" in relation to acreage, windbreaks are especially valuable in providing wildlife cover. They create homes for insect eating birds as well as providing valuable winter cover and travel lanes for upland game animals.

Most windbreaks are made up primarily of conifers, but their wildlife value can be improved considerably by the addition of shrubs. Conifers good for windbreaks include jack, red, scotch, or white pine, while shrubs good for such plantings are bush honeysuckle, autumn or Russian olive, dogwood, and multiflora rose.

Pine rows should be 8 to 10 feet apart with the trees 6 to 8 feet apart in the rows. Shrubs should be about 4 feet apart in the row and the rows 8 to 10 feet apart. Windbreaks may consist of 4 or more rows with the inner rows being conifers and the outer rows made up of the shrubs. Single row conifer plantings have some wildlife value but this value increase with larger plantings.

Windbreaks should all be protected from fire and grazing. In addition, they should be cultivated for the first 2 years after planting or treated with herbicide to assure maximum growth and development.

Wetlands

Marshes or wet areas on many farms can produce an abundant crop of ducks, muskrats, mink, and other related animals.

In general a marsh should be managed either for fur-bearing mammals or for waterfowl. Either form of management needs a dependable water supply, waterlevel controls, and the right kinds and amounts of vegetation for feeding, nesting and resting.

Many wetlands become so overgrown with marsh plants that there are no areas of open water. Such areas can be improved greatly for ducks by removing strips 30 to 50 feet wide. Methods of removing undesired vegetation include spraying with herbicides or the use of draglines. Temporary clearings can be made by mowing when the marsh is dry.

Loafing spots are important to waterfowl. Small islands, knolls, sandbars, open margins, or exposed mudflats are valuable for this purpose. In addition, artificial floating platforms are often used by waterfowl.

Marshes in duck nesting areas should have 6 or more inches of water for at least 3 months in the spring and early summer. If the

This water area features an excellent shoreline for waterfowl usage.

farm's wet area does not have sufficient water, it can be provided by digging or blasting one or more holes over 30 feet in diameter and 2 to 3 feet deep.

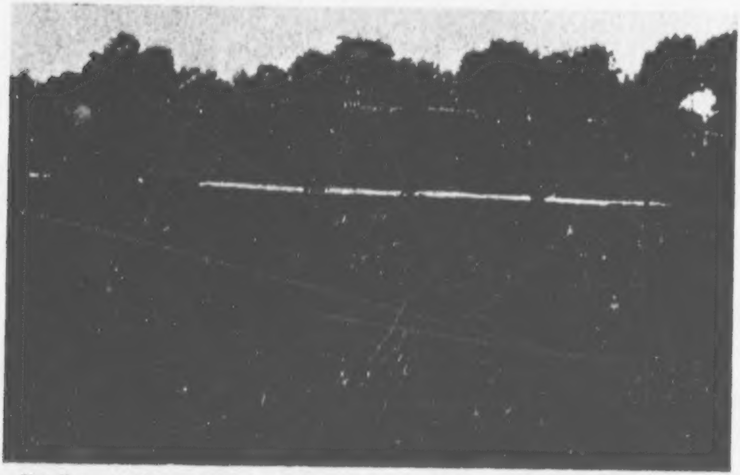
To manage a larger marsh for waterfowl by controlling water levels, there are two choices. One method is to draw the water down enough to keep the soil moist—but with no water on the surface—during the growing season. This will favor the growth of smartweed, burreed, wild millet, and other good waterfowl foods. In the fall the area should be flooded to a depth of 1 to 15 inches. This method produces the most duck food but does not provide nesting for waterfowl or homes for muskrats.

The second method is to maintain the water level between 15 and 30 inches throughout the season. This will favor the growth of waterfowl-food plants like wild celery, sago, arrowhead, naiads, duckweed, and stone wort and other pond weeds. These are fair to good duck foods and of some use to muskrats as well.

To manage a marsh for muskrats the water level should be held at about 6 inches during the summer to encourage the growth of muskrat-food plants such as cattail, burreed, arrowhead, and bulrush. Then during the fall and winter the water level should be maintained at about 2 feet.

Pond Sites

Many farms have at least one pond. While ponds are usually built for soil erosion and flood control, or water storage for livestock, irrigation, or fire control, they are also highly valuable for wildlife.



Shoreline vegetation and upland plantings combine to make a pond pleasing to the landowner and wildlife.

Farm ponds should be fenced to exclude livestock. This is important to protect the fill, spillway, and pond banks from trampling, and to provide a filter strip of grass to remove silt from the water before it reaches the pond. By fencing the pond, an excellent area to develop for upland wildlife is created.

Multiflora rose or other shrubs may be used to create hedges. Shrubs and conifers can be planted in small clumps to provide varied food and cover. If there is to be any fishing in the pond, a strip at least 25 feet wide should be kept clear of shrubs and trees along the pond edge.

All raw areas above the waterline should be seeded to grasses and shallow-rooted legumes like alsike clover, red clover, or Korean or common lespedeza. Never plant trees, shrubs, or deep rooted legumes like alfalfa, sweetclover, or sericea lespedeza on the fill.

Summing Up

Wildlife management on most farms consists principally in doing a good job of conservation farming.

The wise landowner doesn't graze his woodlots, marshes, and streambanks. He won't burn fence rows, pastures, and lowlands. Such negative measures with the addition of positive programs, will help to assure continuous yields of woodland products, conserve soil fertility, and encourage useful wildlife.

The positive program is a trademark of the progressive farmer. He will make use of grass-legume field borders, contour hedges, and living fences. He will permit the development of natural-brush cover and hedgerows. Doing this, he will reduce soil washing, promote absorption of water by the land, obtain windbreak benefits, distribute insect and rodent-eating birds and mammals through his fields, and add much to the beauty and value of his farm.

WILDLIFE MANAGEMENT WITH HERBACEOUS COVER

Management Series No. 4

INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
607 State Office Building
Indianapolis, Indiana 46204

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WILDLIFE MANAGEMENT WITH HERBACEOUS COVER

ALGER F. VAN HOEY
Wildlife Management Biologist

Wildlife biologists are learning to recognize the basic habitat requirements of many of our wildlife species, especially in terms of seasonal combinations of vegetative types that furnish food and cover. This combination or mixture permits an animal to satisfy its basic requirements with a minimum of movement and thus a maximum of security throughout the year. The more these various cover types are broken up and mixed together, the more individual "home ranges" there will be where animals can survive. A characteristic condition known as edge effect or interspersion is created and the habitat can then support a higher population of wildlife.

It is a known fact that almost all game animals and birds include herbaceous plants and seeds in their diet. Therefore, the establishment and improvement of intersperions of herbaceous plant cover is a wildlife habitat improvement measure with broad application. Obtaining good stands of such cover is relatively easy providing certain rules are followed.

Site Selection

Select planting sites for herbaceous cover that will be beneficial to wildlife, relatively inexpensive to establish, and/or an improvement to the land itself. If possible, there should be some tentative habitat improvement plan governing site selection and type of seed sown. A wildlife biologist can usually offer helpful suggestions with planning and is always ready to assist the landowner.

Site selection of wildlife plantings may coincide with other land management activities. Some activities which offer opportunities to establish herbaceous cover at low cost are timber stand improvement, patch cutting of timber, soil stabilization of gullies and critical slopes, utility right-of-ways, and restoration of borrow pits. It is often possible to choose desirable wildlife foods for either part or all of the seeding mixture for these areas. Coordination of this nature is an economical way to achieve herbaceous cover improvement.

More apparent locations for seeding of herbaceous cover are grassed waterways and diversion terraces, around pond sites, headlands and borders of cropfields, land used in federal retirement programs, stripcropped fields, field borders around woodland, "odd areas" on a farm, borders along fencerows and windbreaks, and idle land being improved as farm game habitat.

A sericea strip provides needed winter cover along the edge of a field or woods.

Site Preparation

Random broadcasting over areas not having seedbed preparation has resulted in thousands of pounds of seed being needlessly wasted. Broadcast seeding has proven successful on disturbed or exposed soils, but even here some treatment is desirable to insure that seed is covered with soil. Ordinarily, the best chance for successful establishment of herbaceous cover is provided by regular farming methods.

Given adequate soil moisture and growing season, the five essential steps to site preparation and seeding are: 1) removal of woody competition and residual vegetation, 2) application of fertilizer, 3) inoculation of legume seed, 4) correct seeding rate, 5) proper planting depth and cover of seed.

Some sites have woody vegetation that must either be worked around or removed to properly prepare a seedbed. Small clumps of briers and brush left among herbaceous cover provide excellent shelter for many species of wildlife, but it is not always practical to leave them when preparing a seeding site. If removal of woody vegetation is unavoidable, brushpiles should be built near and in the newly established cover to provide hiding places for rabbits, quail and songbirds.

Next, the ground must be worked to have a seedbed of exposed mineral soil for the seed to germinate and grow. This task is best accomplished by first plowing and then discing as many times as needed to obtain the desired seedbed and to eliminate as much of the residual vegetation as possible. The type of equipment required for the job will vary with the site and cover conditions already present. Eroded areas may require little or no working of the exposed soil prior to seeding.

Natural herbaceous vegetation and multiflora rose travel lane provides excellent wildlife escape cover.

Fertilizing

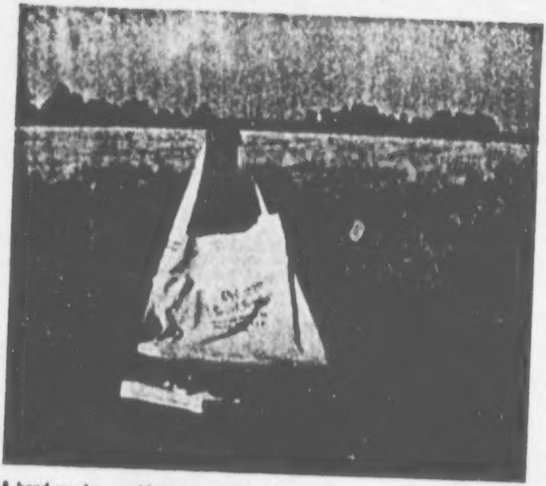
Seedbed preparation is followed by fertilizing and then seeding. The application of fertilizer can greatly improve herbaceous cover production and should be used along with lime according to a soil test. The soil test prevents unnecessary waste and assures the right kind of fertilizer and proper amounts of lime for the type of cover being established. The best time to fertilize and seed is in early spring when the moisture content is high in the soil.

Seeding

Seeds of legumes produce better if they are inoculated with a nitrogen fixing bacteria prior to sowing. This is particularly true in areas where the legume has not been grown previously. Inoculants come in powdered form and may be mixed, either moistened or dry, with the seed at time of planting. Inoculation gives the seed every opportunity to succeed and results in more successful stands of herbaceous cover. Be sure to use the right inoculant for the legume being seeded.

Now comes the actual seeding operation itself. It is important when seeding to determine the correct seeding rate that allows sufficient seed to insure a good stand. A reason to avoid heavy seeding is the unnecessary cost entailed. Besides, stands are not usually materially improved by excessive seeding. Depending on the sites involved and the method employed, 8 to 20 pounds per acre of total seed is adequate. Ordinarily, when drilling, 8 to 10 pounds per acre are advised and in broadcasting 15 to 20 pounds are recommended (Refer to Tables 1-2-3).

Most small seeding jobs can be easily handled with an inexpensive hand seeder. By simply turning a handle as you walk along, this type of seeder broadcasts seed quickly and uniformly over a wide area. The seeder is adjustable to accommodate a variety of seed and seeding rates and can be purchased from almost any farm store.



A hand seeder combines ease of sowing with uniform coverage of seed.

The final step in establishing good herbaceous cover is proper planting depth and cover of seed. As a general rule, grass and legume seed should be covered to a depth of 1/4 to 1/2 inch. An exception to this is the lespedezas which usually are not covered. However, if the ground is too hard, a light harrowing is beneficial after seeding lespedezas. Freshly prepared ground or loose seedbeds should be rolled or otherwise firmed. A well-prepared seedbed that is firmed before and after seeding helps insure a uniform planting depth and close contact of the seed with soil and moisture.

Types of Herbaceous Cover

There are three main types of herbaceous cover: grains, grasses and legumes. The various types are most effective as food and cover for wildlife when sown in strips 30-50 ft. wide, either individually or better yet in mixtures.

Grains are used mainly in food plots near brushy areas, woodland edges or dense fields. In most cases different grain species may be mixed together to provide food for a greater variety of wildlife. Some good grains to choose from are: barley, browntop millet, buckwheat, corn, oats, rye, sorghum and wheat (Refer to Table 1).

Grasses can be either the sod-forming or clump-forming variety and are usually seeded with a legume for best results. Grasses provide wildlife with both nesting cover and food. A list of grasses to consider includes: Kentucky bluegrass, smooth brome, reed canarygrass, orchard grass, redtop, switchgrass and timothy (Refer to Table 2).

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When mature this sorghum food plot will furnish ideal winter food and cover for wildlife.

Of the three types of herbaceous cover, the legumes come closest to fulfilling most of the major food and cover needs of wildlife. Legumes are sometimes sown alone but more often they are combined with a grass to enhance their wildlife value. Some good legume species are: alfalfa, birdsfoot trefoil, clovers (alsike, ladino, white, red), cowpeas, crownvetch, Korean lespedeza, sericea lespedeza, partridge pea, soybean and sweet clover (Refer to Table 3).

Among the legumes the lespedezas warrant particular mention since they have been featured in many wildlife programs in the southeastern United States. Sericea lespedeza (*lespedeza cuneata*) is outstanding as a legume because it is easily seeded, site tolerant, and has superior erosion control and wildlife cover characteristics. Well-distributed winter cover is a primary need of the cottontail, and this perennial legume provides excellent winter cover in most situations. Other lespedezas such as Korean (*lespedeza stipulacea*) are more useful in quail management

Timothy and red clover field next to corn is good nesting cover for rabbits, quail and pheasants.

Sericea lespedeza has been featured in many wildlife programs in the southeastern United States.

because of the abundant food it produces. It should be noted that lespedezas are normally more successful in the southern half of Indiana and other legumes are normally recommended for northern areas.

Plant Mixtures

Mixing grasses with legumes usually increases total production, provides more variety and improves the nutritive value of the forage over single species stands. A good reason for using mixtures is to put different plant species on the site conditions to which they are best suited. Site and soil characteristics can change often and dramatically within a limited area.

Not to stray off the subject of herbaceous cover, but a total wildlife development combines grasses and legumes with shrubs and grain plant-

Strip mowing creates alternating tall and short cover for wildlife.

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A combination of herbaceous and woody cover around the edge of a pond enhances wildlife use.

ings. Large, non-forested areas supporting grasses and legumes can be improved for wildlife by planting strips not over 20 ft. wide with shrub species such as japonica lespedeza, autumn olive and in the north, multiflora rose. Such wildlife shrubs along with pine trees may be used around the perimeter of croplands, on strip-mine slopes and in abandoned fields.

Another way to achieve an interspersion or mixture of cover types is by combining strips of planted herbaceous cover with strips of natural vegetation. If strips of land are mowed or disced and then left idle, native grasses and weeds will soon come in. This method provides a greater selection of food and cover types for the wildlife species present. A thought to keep in mind: the more you vary the cover types, the more numbers and various kinds of wildlife will be produced.

Seven Rules to Successful Herbaceous Cover

1. Plan the project with a definite goal to improve specific wildlife habitat requirements. A wildlife biologist can help determine the needed requirements.
2. On areas too steep, rocky or erodible for easy cultivation, plant durable herbacious cover such as crownvetch, sericea lespedeza or fescue. Where maintenance and restoration is possible, plan on periodic renovation of the herbaceous cover.
3. Ground preparation is usually necessary to reduce other competitive plants and expose the seed to mineral soil. Fertilize and lime according to a soil test.
4. Plant adapted species and strains and plant mixtures on variable sites while using sufficient seed to insure a good stand.
5. A "nurse crop", usually a light seeding of oats or wheat, help control competition and offer shade to young plants.
6. Follow seed planting with seed bed firming.
7. Control weed invasion by mowing at least 8 inches high once in late summer the first year after planting.

TABLE 1

Species	Principal Use	pH Preference	Moisture Tolerance	Shade Tolerance	Fertility Minimum	Seeding Rate Per Acre	Time of Seeding
GRAINS:							
Barley	Geese feed on foliage of young plants. Grain is food for Hungarian partridge, pheasants.	6.5-7.8	Well-drained	Low	Moderate	2 bu.	Fall or Spring
Browntopmillet	Food for ducks, doves.	5.5-7.0	Wet to well-drained	Low	Low	20-25 lbs.	Summer
Buckwheat	Food for mourning doves, Hungarian partridge, deer, songbirds, ducks.	5.5-7.0	Drouthy to well-drained	Low	Low	3-4 pks.	Summer
Corn	Outstanding wildlife food. Used by more than 100 species. Important for pheasants, quail, Hungarian partridge, mourning doves, ducks, geese raccoons, squirrels, and many songbirds.	5.5-7.5	Well-drained	Low	Moderate	7-12 lbs.	Spring
Oats	Food for Hungarian partridge, pheasants, wild turkeys, many songbirds.	5.0-7.5	Well-drained to moderate	Low	Moderate	1½-3 bu.	Spring
Rye	Foliage is food for cottontails, deer, geese. Seeds used by pheasants, quail.	5.0-7.0	Drouthy to well-drained	Low	Low	5-6 pks.	Fall
Sorghum	Food for quail, wild turkeys, ducks, many songbirds.	5.5-7.5	Drouthy to well-drained	Low	Moderate	5-15 lbs.	Spring
Wheat	Use as food by 94 species of wildlife. Winter wheat foliage is an important food of geese and cottontails; also used by deer. Grain is important for mourning doves, Hungarian partridge, many songbirds. Also used by pheasants, quail.	5.5-7.5	Drouthy to moderately well-drained	Low	Moderate	1½-2 bu.	Fall or Spring

[1] Seedling rates of grasses (except creeping bent and reed canarygrass) and legumes (except crownvetch, partridge pea and soybean) are based on seeding in a grass-legume mixture. If sown alone, double the rates shown. Seeding rates are somewhat lower than those commonly used to establish meadows and pastures. This is intentional since a somewhat less dense stand is desired for wildlife cover.

TABLE 2

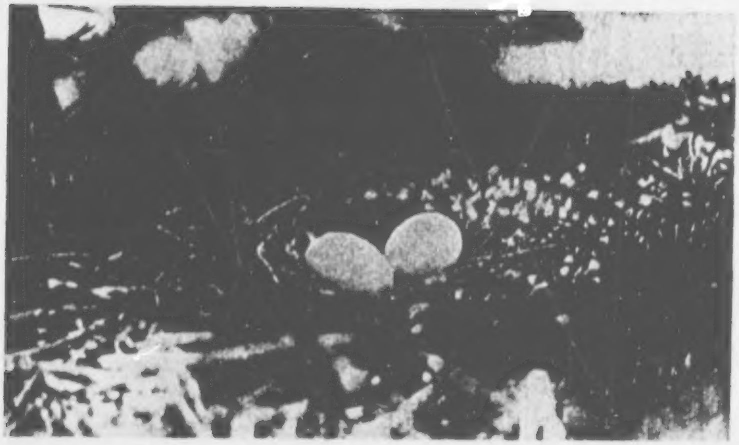
Species	Principal Use	pH Preference	Moisture Tolerance	Shade Tolerance	Fertility Minimum	Seeding Rate[1] Per Acre	Time of Seeding
GRASSES:							
Bluegrass, Kentucky	Pond areas, odd areas. Nesting cover for pheasants, quail, rabbits, songbirds. Food for rabbits.	5.5-7.5	Medium to well-drained	Moderate	Moderate	4-6 lbs.	Fall or Spring
Brome, smooth	Border stripe, odd areas, pond areas. Nesting cover for pheasants, quail, rabbits, songbirds. Food for deer, rabbits.	6.0-7.0	well-drained to drouthy	Low	High	4-6 lbs.	Fall or Spring
Canarygrass, reed	Streambanks, seeding intermittent potholes, gullies. Nesting cover for pheasants, rabbits. Food for rabbits.	6.0-7.0	Wet to well-drained	Moderate	Moderate	4-5 lbs.	Fall or Spring
Orchardgrass	Woodland borders. Nesting cover for gamebirds, rabbits, songbirds.	6.0-7.0	Medium to well-drained	High	Low	4-6 lbs.	Spring or Fall
Redtop	Odd areas, pond areas. Nesting cover for gamebirds, rabbits, songbirds. Little use as food.	5.0-6.0	Wet to well-drained	Moderate	Low	3-5 lbs.	Spring or Fall
Switchgrass	Field borders, odd areas, pond areas. Nesting cover for pheasants, quail, rabbits, songbirds. Food for songbirds, quail, rabbits.	5.5-7.0	Moist to well-drained	Moderate	Low	5-8 lbs.	Early Spring or Summer
Timothy	Field borders, odd areas, pond areas, woods openings. Nesting cover for game birds, songbirds, rabbits. Food for rabbits, deer, songbirds.	5.5-8.0	Moist to well-drained	Moderate	Moderate	3-4 lbs.	Fall or Spring

TABLE 3

Species	Principal Use	pH Preference	Moisture Tolerance	Shade Tolerance	Fertility Minimum	Seeding Rate[1] Per Acre	Time of Seeding
LEGUMES:							
Alfalfa	Field borders, odd areas, pond areas. Nesting cover for game birds, cottontails. Food for rabbits, deer.	6.2-7.8	Drouthy to moderate	Moderate	Moderate	4-6 lbs.	Spring or Summer
Birdsfoot trefoil	Food for ruffed grouse, deer, cottontails. Nesting cover.	5.0-8.0	Wet to well-drained	Low	Low	4-6 lbs.	Spring
Clover: alsike	Field borders, odd areas, pond areas, woodland openings and roads. Nesting cover. Foliage is food for ruffed grouse, wild turkeys, woodchucks, cottontails, deer.	5.5-7.5	Poorly drained to medium	Low	Moderate	2-4 lbs.	Spring
Ladino, white		5.5-7.0	Poorly drained to well-drained	Low	Moderate	1-2 lbs.	Spring
red		5.5-7.5	Medium to well-drained	Low	Moderate	5-6 lbs.	Spring
Cowpeas	Food patches. Seeds eaten by mourning doves, quail.	5.5-7.0	Well-drained	Moderate	Moderate	8 lbs.	Spring
Crownvetch	Critical area stabilization. Cover for rabbits. Food value limited.	5.5-7.5	Medium to well-drained	High	Low	5-15 lbs.	Spring
Lespedeza, Korean	Field borders, odd areas, pond areas. Topnotch food for quail; also used by deer. Some cover values.	4.5-6.5	Drouthy to well-drained	Low	Low	10-15 lbs.	Spring
Lespedeza, sericea	Field borders, woods borders, odd areas, pond areas. Excellent cover for cottontails, quail.	4.5-6.5	Drouthy to well-drained	Low	Low	25-30 lbs.	Spring
Partridge pea	Odd areas, pond areas, woods borders. Good food for quail.	5.5-7.0	Drouthy to well-drained	Moderate	Low	15-25 lbs.	Spring
Soybean	Food patches. Seeds eaten by mourning doves, quail, pheasants. Foliage eaten by cottontails.	6.0-7.0	Drouthy to well-drained	Low	Moderate	25-30 lbs.	Spring
Sweetclover	Field borders, odd areas. Nesting cover, roosting cover. Seeds are food for Hungarian partridge, to lesser extent for pheasants.	6.5-7.5	Drouthy to well-drained	Low	Low	2-4 lbs.	Spring

WILDLIFE MANAGEMENT WITH TREES AND SHRUBS

Management Series No. 5



INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
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WILDLIFE MANAGEMENT WITH TREES AND SHRUBS

by

GEORGE KENNEDY
Wildlife Management Biologist

Wildlife species that are dependent upon trees and shrubs for their existence number close to two hundred in Indiana. Unfortunately as man has cleared the land for roads, agriculture, housing developments, factories and numerous other projects the number of acres in trees and shrubs has steadily decreased. However, in recent years, many federal state and private conservation organizations as well as individual landowners have made considerable progress in identifying the best uses of our land resources. Many acres once cleared are being replanted to trees and shrubs.

Most Hoosiers believe the largest number and variety of wildlife species can be raised by planting exotic shrubs and trees not native to Indiana. However, almost invariably the opposite is true. If the latter is correct, why not use all native plants to establish tree and shrub stands for wildlife? Most often, the landowner will not make the considerable effort needed to transplant native species to establish a fencerow or other conservation planting. Most native woody plants that do the most good are "Old Hat" to the landowner. They like to experiment with unfamiliar species and varieties, and most important, they usually want the plants to "stay put". Our plants, being native to the state, are able to sustain their populations through various reproductive methods and as a result have a tendency to spread. Also, our state nurseries have experimented with a large number of native species and found many difficult to raise economically or found little public demand for them. However, a generous supply of native and imported species are raised annually by our nurseries for sale to Hoosier landowners. Most of the exotics raised by the state nursery are easily controlled or do not spread. Most are adaptable to a wide variety of sites and growing conditions. They give the landowner a method to choose a plant community for a site for many years. At present, the best course to follow to get the woody plant conservation job done is to use a combination of imported and native species.

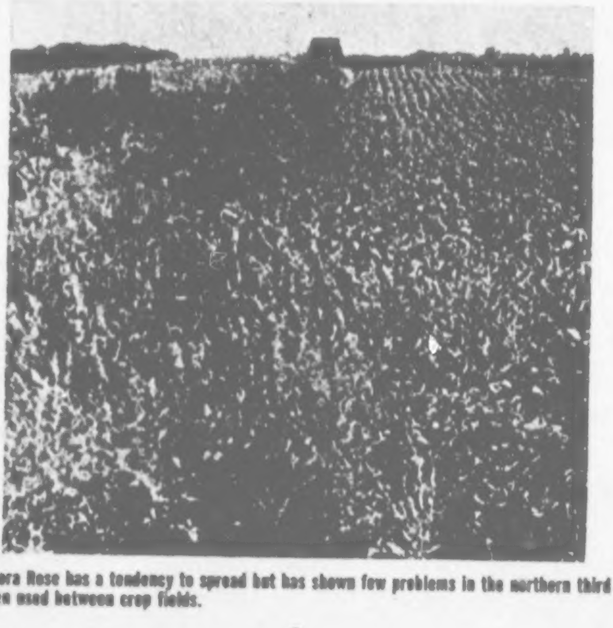
How do you go about designing plantings of trees and shrubs to benefit wildlife while providing for conservation, recreation and income? Below are discussed several planting designs and management methods for new and established stands of trees and shrubs.

FENCEROW & FIELD EDGE PLANTINGS

In the following discussion familiar woody species for wildlife are used as examples. Other species could be substituted for those mentioned, but the management principles would remain the same.

The northern quarter of Indiana is known as the snow-belt region. Here, the most severe winter weather occurs. Plantings must be more extensive than over the rest of the state. In the north the movements of most small game are restricted unless dense woody cover is available near feeding areas. Farther south in the state, grass-legume cover stays erect through most of the winter and woody cover need not be so extensive. In the south an 8 to 12 foot wide strip of grass-legume cover under a single row of autumn olive along a fencerow produces an excellent travel lane three years after planting. In the north usually two rows of autumn olive are needed to make a good travel lane. If brushpiles are built every 200-250 feet in the travel lane, the benefits to small game are substantially greater.

Often, 2 or 3 rows of pines are planted along one side of a single row of autumn olive or multiflora rose to act as a windbreak and improve nesting, escape and winter cover. If two rows of pines and one row of shrubs are planted, a forty foot wide wildlife strip is created. Plant small corner or odd area plots that are difficult to crop with 6 to 25 shrubs and trees and connect these with travel lanes. If a brushpile or two can be added to each of these odd area plots, the value to wildlife is greatly increased. Locating the plots in low areas, especially in the snow belt region, reduces the effects of winter weather. Here, their presence often determines if small game will stay in a local area or seek more extensive lowlands.



Multiflora Rose has a tendency to spread but has shown few problems in the northern third of the state when used between crop fields.

Multiflora rose grows more dense than autumn olive. One row of multiflora provides as good a travel lane as two rows of autumn olive. When planted primarily for wildlife use or as a windbreak, the seedlings may be spaced 1 to 3 feet apart. When used as a living fence for cattle, sheep, horses, or goats, two rows should be planted 8 to 10 feet apart with the seedlings 1 to 2 feet apart within the rows. In the southern two-thirds of Indiana, care should be exercised in deciding whether or not to plant multiflora rose because of its tendency to spread. In the northern third of the state, spreading may also occur but to a lesser extent. Serious spreading problems most often occur when poor conservation practices are being employed. Examples of poor conservation practices are pasturing of woods and thickets, over-pasturing of hay fields, over-cutting of woods and poor fertility maintenance resulting in extensive erosion of sod fields. All of these abuses cause thin sods where volunteer seedlings may easily become established.

Shrub species such as multiflora rose, which have a tendency to spread and possibly cause problems, are best used in highly cultivated areas where row cropping takes place. Here, a travel lane of a shrub species of this type is located between two or more crop fields where plowing and discing takes place most years. The few seedlings that do volunteer in the crop fields are destroyed by the normal farming operations. No additional effort is needed to prevent spreading.

Japonica lespedeza and other shrub lespedezas have been used for wildlife and other conservation plantings in Indiana for many years. The stems of Japonica usually die back to the ground each winter in

Japonica Lespedeza supplies both food and cover when used as a travel lane or field edge planting.

the northern third of the state, while seldom doing so further south. However, if the stems are winter killed, each spring new stems 6 to 8 feet tall are produced on well established plants. As the years pass the number of dead stems accumulate and more new stems in larger quantities are produced annually. The result is better protection for wildlife. In addition, the pink flower display becomes increasingly spectacular each year. The seeds produced usually remain from one year to the next in increasing quantities on the ground under the plants. This seed is excellent food for quail, partridge and many songbirds. Spacing of plantings should be no wider than 4 feet by 4 feet for a travel lane with a minimum of two rows over the southern two-thirds of the state and three rows in the north.

Both autumn olive and Japonica lespedeza have considerable hardiness. They are frequently planted on poor soils gullied by erosion. Their fibrous root systems soon cover the eroding area and greatly reduce additional erosion.

CHRISTMAS TREE PLANTATIONS

Ask a sportsman who has hunted cottontails for many years about these plantations and invariably his eyes will light up from pleasant memories. The properly managed plantation has a continuous rotation by harvesting mature trees and planting new seedlings. As a result, the understory of grasses and legumes rarely gets shaded out by the conifers. This management yields paradise for the rabbit, bobwhite, quail, pheasant (where soils are suitable), and many songbird species.

Conifer plantations, if managed properly, both produce and attract numerous wildlife species.

If the field to be planted to conifers is fallow, establish a good stand of a grass-legume mixture on the plantation site. Avoid liming since conifers suffer from its application. If the grass-legume mixture is fertilized, apply the fertilizer one year before planting the conifers. If needed, mow or use herbicide the first two-three years after planting and discontinue when the trees are taller than the grass. By mowing around younger age classes *only* and having these next to each other in the field, browsing damage from rabbits and rodents is minimized. Also, the bark of the older trees is too coarse to be digested by small browsers and the standing grass-legume cover attracts wildlife away from the young trees.

Before planting a Christmas tree plantation, investigate the special care needed to produce high quality trees. Some practices are not compatable with the best wildlife development. You will have to weigh benefits. Above all be conservative! It is much easier to plant seedlings than it is to take care of the trees as they mature.

Proper woodland management can produce timber and be beneficial to many wildlife species.

WOODS EDGE MANAGEMENT

Most of our woodlots are less than 40 acres in size. Proper management results in uneven aged trees with group and individual selection used to harvest mature trees. In the properly managed woods, seedlings for wildlife browse are available as well as mature trees with fine den sites and heavy fruit production. The uneven-aged woods properly managed on a continuous yield basis produces an excellent return in timber sales and wildlife species. Woodlot border management can be accomplished on any side of a woods. However, low growing trees, shrubs, and herbaceous plants which make up these woodland borders do best on the east, south or west sides where they receive more sunlight. Special efforts should be made to establish protective borders along the west and north sides, since prevailing winds cause the most damage there.

In woods-edge management, planting of new seedlings or cutting of existing trees are made to encourage plant growth which in cross-section appear like a staircase. The steps lead from the field to the tallest trees of the woods interior. The shrub and low growing tree portion is 30-40 feet wide with plants 6-40 feet tall. Use from one to four rows of shrubs or small trees on the woods edge.

Pines, spruces or other tall growing conifers may be planted along the woodland edge. However, when the trees are 15-20 feet tall the leaders are pruned to prevent them from shading out beneficial plants. An underplanting of a grass-legume mixture or just legumes is recom-

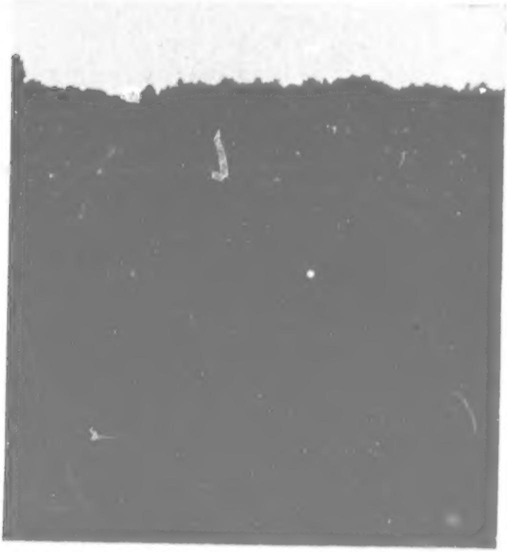
Over 47 species of birds feed on dogwood berries. The grey dogwood pictured above grows well in most areas of Indiana.

mended. Also, a food plot 15-20 feet wide or a grass-legume or legume strip 10-15 feet wide may be planted on the outside edge of the shrub-tree border. Total width of the edge planting with an herbaceous strip varies from 30-50 feet. In addition, brushpiles are placed every 100-200 feet in sunny locations along the border. This combination produces outstanding wind protection, erosion prevention, pleasant views, and wildlife cover and food.

ODD AREAS

Odd areas can best be described as land not used for agriculture or timber production. Abandoned gravel pits, small three-cornered areas not farmed, areas around ponds, old railroad rights-of-way and areas too dry or too wet to farm are good examples. Shrubs and some trees planted on these areas are often necessary for a complete wildlife development.

Shrubs are most important as shelter for wildlife. Follow the tracks of a covey of bobwhite quail through the snow. You will soon discover that quail seldom venture far from shrubs or other woody cover during the winter. If they forage in a field, they do most of their feeding within 100 feet of woody cover. To get them to travel further into the field, small grain stubble, corn stalks or other similar cover must be present. A quail knows to venture far from the protection of woody cover in the winter invites disaster.



A combination of red pine, shrubs and sericea lespedeza produce wildlife on "odd areas".

Shrubs good for nesting sites, fruit production and weather protection include thorn apple, staghorn sumac, blackberry, raspberry, viburnums, and dogwoods. Brushpiles placed next to grape vines, Virginia creeper, and bittersweet are soon overgrown and make very effective wildlife cover. Trees planted in odd areas should be selected to provide wildlife food in the form of acorns, nuts or berries. Some good wildlife food producing trees would be the oaks, hickory, walnut, sassafras, and black cherry. Where cover is required, the conifers should be chosen. If shrubs and trees are used together on a small area, visualize the tree growth in 20 years or more and determine if adequate sunlight will be available to the shrubs.

DETERMINATIONS BEFORE PLANTING

A decision to plant trees and shrubs should be reasonably final. The cost of planting, care of seedlings, and the interval of time to reach productivity should rule out snap judgements and subsequent change in land use.

The second determination would be the type of woody material most suitable for the site in question. Tree and shrub growth characteristics often demand specific site requirements regarding sunlight intensity, soil fertility, available moisture and spacing. (Refer to Guide) The best chance of success requires the planting of trees and shrubs on the sites most tolerant of their specific requirements.

The tiling spade (right) and planting bar (left) are the tools of the hand planter.

The determination of number of seedlings to be planted usually depends on the planting technique to be used and the size of the area to be planted. Hand planting by the landowner, though personally satisfying, is seldom recommended for over a thousand seedlings in one year. With the use of a planting bar or tiling spade, approximately 50 to 75 seedlings per hour would be a fair planting average for most landowners. If the project becomes tiresome and appears too large to handle, the quality of planting is usually affected.

Custom tree planters are usually contacted for larger plantings. In most cases these people are professional foresters and are equipped to plant thousands of seedlings in one day. Plantings are made with tree planters or by hand planting. All custom tree planters have the equipment and knowledge to apply herbicides. Most of the professional employees in state or federal conservation programs have knowledge of custom tree planters available in their area and can help the landowner in selecting the best method of seedling planting.

SEVEN STEPS IN SEEDLING PLANTING

1. Plant as soon as possible after receiving seedlings.

2. If planting cannot start within 5 days after receiving seedlings, remove the seedlings from the packing material and "heel in". "Heeling in" consists of digging a shallow trench, laying the seedlings in the trench with the tops exposed and covering the roots with soil. Water thoroughly and keep moist.

3. While planting, carry the seedlings in a container with water so the roots are never allowed to dry.

4. Plant the seedlings at the same depth that they were growing before removal from the nursery.

5. If the roots are too extensive for easy planting, cut back only enough to accommodate planting. Top pruning is normally not necessary.

6. Firm the soil around each seedling to insure that all the air pockets are removed from the root zone.

7. Apply herbicide in recommended amounts or plan on other weed control measures, for the first two or three years.

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TREE PLANTING GUIDE

Species	Soil Requirements							Drainage			Light		Height	Spacing	
	Acid	Neut	Alk	Sand	Loam	Clay	Fertility	Dry	Medium	Wet	Sun	S-Shade	(ft)	(ft)	Best Use*
White Pine	X	X		X	X		low-high	X	X		X		120	10-12x10-12	abcdefhi
Red Pine	X	X		X	X		low-mod	X	X		X		100	10-12x10-12	abcdefhi
Scotch Pine	X	X		X	X		low-high	X	X		X		70	6-12x10-12	acdefhi
Jack-Va Pine	X	X		X	X		low-mod	X	X		X		40	10-12x10-12	acdefh
Wh-Blk-Bl-Red Norway Spruce	X	X		X	X	X	low-high	X	X	Blk	X	X	30-100	6-12x10-12	abcdefhi
Balsam Fir	X	X		X	X		low-high		X	X	X	X	80	6-12x10-12	a-i
Red Cedar	X	X		X	X	X	low-high	X	X		X	X	60	6-12x8-10	a-h avoid near apple
White Cedar	X	X		X	X		mod-high		X	X	X	X	125	10-12x10-12	a-h
Red-Wh Oak	X	X		X	X		low-mod	X	X		X		150	10-12x10-12	d-h
Pin-Bur-Swamp White Oak	X	X		Pin	X	X	low-high	Pin	X	X	X		90-170	10-15x10-15	d-h
Blk Walnut Butternut		X			X		mod-high		X		X		40-90	10-12x10-12	d-g
Pecan-Hickory	X	X		Hick	X		low-high	Hick	X	Pecan	X	X	90-160	10-12x10-12	d-h
Am Beech-Blk Cherry		X	X		X	X	mod-high		X		X		120	10-12x10-12	d-g
Redbud-Fl Dogwood	X	X	X	X	X		mod-high		X		X	X	40-50	8-12x10-12	adefg
Blk Locust Sassafras	X	X	X	X	X	X	low-high	X	X		X		90	10-12x10-12	aefgh
Mulberry	X	X	X	X	X	X	low-high	X	X		X		80	10-12x10-12	a-h
Fruit Trees	X	X	X	X	X		low-high	X	X		X		8-30	10-20x10-20	abdefgh

* Best Use: a-travel lane, b-windbreak, c-winter cover, d-escape cover, e-odd areas, f-nesting, g-food, h-erosion control, i-Christmas trees

SHRUB PLANTING GUIDE

Species	Soil Requirements							Drainage			Light		Height	Spacing	
	Acid	Neut	Alk	Sand	Loam	Clay	Fertility	Dry	Medium	Wet	Sun	S-Shade	(ft)	(ft)	Best Use*
Bittersweet	X	X	X	X	X		low-high	X	X		X	X	25	3-5x3-5	acdeg on brushpiles
Blackberry	X	X			X		mod-high		X	X	X	X	6	1-2x4-6	acdefg
Blackhaw	X	X	X	X	X		mod-high	X	X		X	X	20	6-10x10-12	a-h volunteers
Blueberry	X			X	X		low-high	X	X	X	X	X	1-10	1-3x2-12	a-h
Buttonbush	X	X	X		X		mod-high		X	X	X	X	8	6-10x6-10	c-h
Cherry, Manchu	X	X	X	X	X	X	low-high	X	X		X		4	3-4x3-4	abegh
Chokeberry		X	X		X	X	mod-high		X	X	X		15	6-10x8-10	e-g
Cranberry, Highbush		X	X		X	X	mod-high		X	X	X	X	10	4-6x6-8	a-g
Dogwood, Gray	X	X			X	X	mod-high		X	X	X		8	3-4x3-4	a-g
Dogwood, Red-Osier; Silky	X	X	X		X	X	low-high		X	X	X	X	10	2-4x2-4	a-h stream banks
Elderberry	X	X	X		X	X	mod-high		X	X	X	X	10	3-4x4-6	a-h stream banks
Firethorn	X	X	X		X	X	low-high	X	X	X	X	X	2-10	2-4x2-4	abdefg
Grapevine	X	X	X	X	X	X	low-high	X	X	X	X	X	30	4-6x8-10	acdefg on brushpiles
Hawthorn, Washington	X	X	X	X	X	X	low-high	X	X	X	X	X	25	6-10x10-12	a-h spread-wet soil
Hazelnut	X	X	X	X	X		mod-high	X	X		X		10	3-4x4-6	a-h
Holly	X			X	X	X	mod-high	X	X	X	X	X	15	4-6x6-10	a-h
Honeysuckle, Amur; Tatarian	X	X	X	X	X	X	low-high		X	X	X	X	15	4-6x8-12	a-h volunters
Juneberry	X	X		X	X		low-high	X	X	X	X	X	15	4-6x6-10	egh

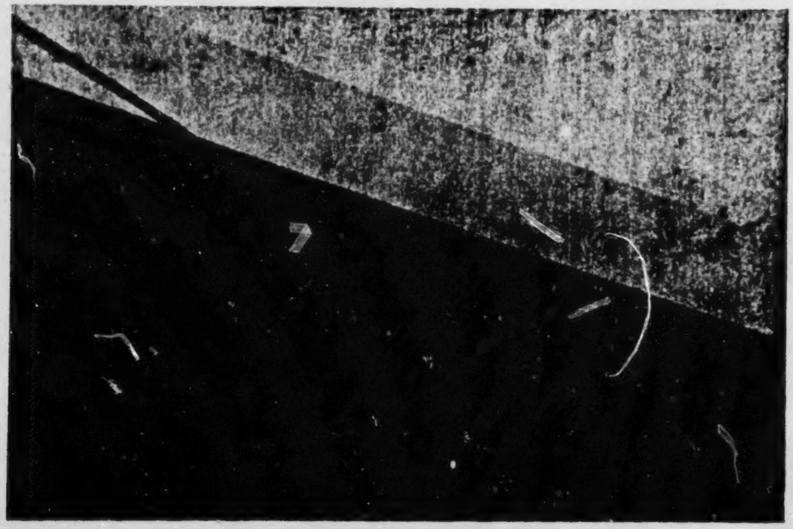
SHRUB PLANTING GUIDE (Cont'd)

Species	Soil Requirements							Drainage			Light		Height	Spacing	
	Acid	Neut	Alk	Sand	Loam	Clay	Fertility	Dry	Medium	Wet	Sun	S-Shade	(ft)	(ft)	Best Use*
Lespedeza, Natob; Japonica	X	X		X	X		low-high	X	X		X		8	3-4x3-4	acdefgh
Nannyberry	X	X	X		X	X	mod-high		X	X	X	X	30	6-10x10-12	a-g
Olive, Autumn	X	X	X	X	X	X	low-high	X	X		X		12	6-10x10-12	a-h
Rose, Multiflora	X	X	X		X	X	mod-high		X	X	X		10	1-2x8-12	a-g volunteers
Rose, Rugosa	X	X	X	X	X	X	low-high	X	X		X		6	1-2x4-6	bcdegh
Sumac, Staghorn	X	X		X	X	X	low-high	X	X		X		12	2-4x2-4	adegh
Willow, Purple-Osier	X	X	X	X	X	X	low-high		X	X	X		15	4-6x6-10	abefgh stream banks
Winterberry	X	X			X		mod-high		X	X	X		8	3-6x6-8	a-h
Yews, Upright; Spreading	X	X			X	X	low-high		X	X	X	X	3-15	3-5x6-12	a-h

* Best Use: a-travel lane, b-windbreak, c-winter cover, d-escape cover, e-odd areas, f-nesting, g-food, h-erosion control

CONTROLLING NUISANCE NON-GAME WILDLIFE

Management Series No. 9



INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
607 State Office Building
Indianapolis, Indiana 46204

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CONTROLLING NUISANCE NON-GAME WILDLIFE

BY DEAN ZIMMERMAN

Wildlife Biologist

Most wildlife species are interesting and enjoyable to have around. Occasionally though, one of them gets out of place and becomes a nuisance. Animals can become pests by damaging or eating something valuable to us, by making noise, or by merely being present.

This publication is meant to be a general guide for assisting the public when an individual animal or a small number become a nuisance. The methods of control presented may not always work since many problems are unique and animal behavior is not always predictable. However, these control methods have worked for others in the past and are among the best available.

No attempt has been made to offer controls for insect, rat, or mouse problems. Information on control of these animals is readily available from any hardware, farm store and pest control agency. Our goal is to provide help in controlling wildlife pest problems where assistance is normally not available.

Each species or group of species will be treated separately in the following pages. Only economical and practical courses of action are recommended. The recommendations should minimize any ill effects to non-target animals.

Home remedies are common in wildlife pest control. Generally they are the cheapest and easiest to use, but some work part of the time, others don't work at all. Success depends on the situation.

What First

The first step is to identify the pest. Most animals leave one or more calling cards. Different signs to look for include: tracks, tooth marks or cuttings, fur, scats, and smell. It's often possible to see or hear the animal. If you have trouble finding tracks, talcum powder sprinkled on a smooth dark surface may help.

Several guides for identifying animals are available. You may want to purchase one at a local book store or most libraries have copies available.

Once the animal is identified, a course of action should be chosen. This action depends on the kind of animal causing the problem and the surrounding circumstances. There are four basic choices for action: 1) live trapping and transporting, 2) killing the animal by shooting, trapping or poison, 3) protecting the product or that which is being damaged by using repellents or physical barriers, or 4) removing the food or cover attracting the animals to the problem area.

If an animal is live trapped, the best disposal is to take it to a remote area in the country near food and water and carefully release it. If the animal is killed, bury the carcass as soon as possible.

Safety is a key word when working with wildlife. Any animal, large or small, is capable of inflicting injury. Normally, any animal will turn and run from humans, but if cornered or threatened, animals will stop and defend themselves. Biting and scratching are the most common ways. In addition to infection which can result from a bite, mammals are capable of transmitting rabies.

Avoid handling animals. When it is necessary, wear heavy gloves, heavy socks or boots and use a firm grip on the animal to prevent personal injury. It may be better to coax the animal into a box or cage for transporting. Sometimes a heavy blanket can be thrown over an animal to temporarily hold it.

When using poisons or repellents, read and follow label directions carefully. Consider that many chemicals may be harmful to desirable animals.

Snakes

Snakes are usually offensive just by their presence. People often fear snakes because they know so little about these unusual and secretive animals. Most snakes are actually beneficial to man because of the many rodents and insects they eat.

Only three poisonous snakes occur in Indiana; the copperhead, eastern massasauga rattlesnake, and the timber rattlesnake. All three species are rarely seen and therefore normally should not be feared.

The best way to keep snakes from a yard is to remove all hiding places. Snakes are attracted to areas where boards, flat rocks, trash piles and similar debris are present, especially in areas of tall weeds and grass.

If you find a snake, carefully remove it with a shovel or pair of sticks to a distant weedy area. If it returns, move it farther away. Killing should only be done as a last resort.

Occasionally snakes enter houses, sometimes by accident, sometimes when searching for food or hibernating quarters. The best control is preventing entry by plugging all cracks and holes. This can be done with mortar, caulking or wire mesh.

If you have a snake in a crack or hard to get at area and it hides before you can catch it, put wet cloths on the floor near where the snake entered and cover with dry cloths or burlap bags. Snakes like moisture and shelter, so they tend to crawl under or between the cloths and can then be removed.

If the snake chooses to be stubborn, try squirting ammonia where the snake is located. This may cause it to leave. Since snakes generally feed at night, wait until a few hours after dark, check to see if the snake is gone, and plug up the entry.

Birds

All wild birds and their nests are protected in Indiana by State and Federal laws except the English sparrow, starling and the feral pigeon. However, members of the blackbird family may be killed when destroying fruit or crops, or when they are concentrated in such large numbers as to create a nuisance or health hazard. In Indiana, the blackbird group would normally include the red-winged blackbird, grackle, cowbird and crow.

There are many different kinds of sparrows or sparrow-looking birds. Learn to identify the English sparrow, male and female, and destroy only this species. All other sparrows are beneficial and in no way become pests.

Four common problems with birds are: indoor roosts, outdoor roosts, large congregations, and depredation on fruit or crops.

Physical Barriers

Indoor roost problems are usually caused by English sparrows and occasionally by starlings and feral pigeons. The best control is to close all openings that allow entry. The most common entry areas are broken windows, and openings around the eaves and large doors. Many small openings can be covered with screen or tin strips. Cracks around large doors may be corrected by making the door more tight fitting, or by filling in cracks with small boards or slats.

Destroy Nests

Destroying nests is effective in controlling unwanted birds in and around buildings. A long pole with a hook on the end should be used about every two weeks to pull down nests.

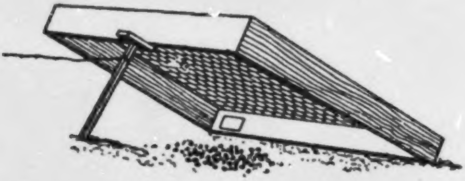
Shooting

Shooting is another way to eliminate indoor roosts. B-B guns, low pressure pellet guns or bird-shot in an old .22 rifle or pistol can be used without damaging the roof. The best time to remove birds is just after dark by using a flashlight to spot and blind the birds. The same technique can be used to remove feral pigeons from outdoor roosts on buildings.

Outdoors, the shotgun is efficient for killing and dispersing flocks of blackbirds and starlings when they are causing damage.

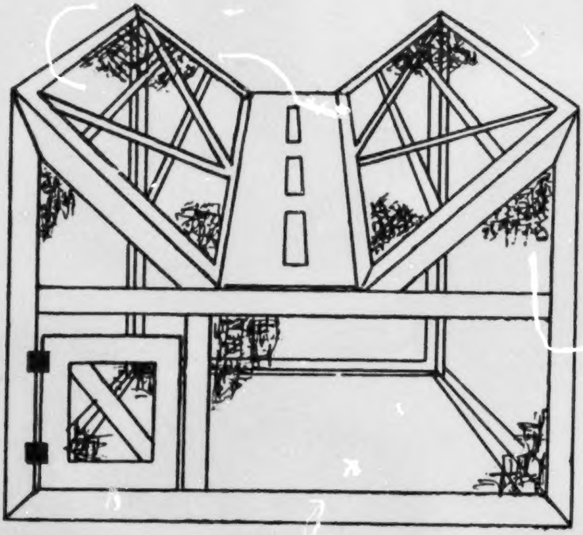
Trapping

Trapping is another way to control birds. Several types of traps can be purchased at hardware and farm stores, or you can build your own. At least two or three areas should be baited with poultry scratch feed, cracked corn, grain sorghum, millet or wheat. Position a trap out at one bait site and move the trap when you go two days or more without catching birds. Keep plenty of bait in the trap.



Sieve Trap

A simple sieve trap can be constructed out of 1 x 4 inch boards. Form a square frame and cover one end with a wire mesh. The trap should be located over an area that has been baited for several days. Prop up one end about 6 inches above the ground with a stick. Attach a long string to the stick and position yourself a long distance away, out of sight. As birds enter the feeding area, the box can be dropped over 1 or more birds.



Center-Drop Trap

The center-drop trap is one of the simplest and best traps. Birds drop through openings in the center to feed and cannot fly out. Build the trap 6′ wide x 6′ high x 8′ long. Use 2 x 2″ material with 1 x 2″ or 1 x 4″ for cross braces and door. Cover the trap with ¾″ meshed wire. Make the throat frame 1½′ wide and cover with chain-link fence with 2″ openings or use ½ to ¾″ wire mesh and cut out a number of 2-3" openings in the center. Leave two to six birds in the cage to act as decoys.

Roost Problems

Large concentrations or roosting flocks of blackbirds and starlings can be annoying or even a health hazard. Late fall or early spring tree and building roosts are usually temporary stopovers for the birds on their way to summer nesting areas or winter roosts.

Smaller roosting flocks can sometimes be dispersed by noise. Noise repellents must be started as soon as the birds flock into the trees and buildings and should continue until the last bird leaves. Scaring must begin early in the evening while there is sufficient light for the birds to find an alternate roost.

When the flock is small, noise can be created simply by hollering, clapping and beating on pans or tin. For larger groups, shotguns, exploding cracker shells for shotguns, gas exploders and recorded starling distress calls may work. Use more than one technique to supplement the other.

Large flocks may require professional help. Advice or help may be obtained by writing the U.S. Fish and Wildlife Service at the address at the end of this booklet.

Miscellaneous Problems

Destruction of fruit and crops by birds is hard to control, especially over large areas. Here again noise is one of the best deterrents. Use the noise techniques mentioned above. For large areas or persistent birds, contact the County Extension Agent or the nearest representative of the U.S. Fish and Wildlife Service In corn fields, a chemical called Avitrol can be used on blackbirds. This involves application of one pound of treated corn per acre. The chemical causes the blackbirds to behave in an abnormal manner, scaring other birds away.

In smaller areas, plastic twirlers, cloth strips, tinfoil or other moving objects may help reduce damage. Fibre netting that completely encloses the crop is one of the best protective measures for small fruit. With careful handling, netting may be used several years. These ideas may be supplemented by an occasional skyward shotgun blast.

Woodpeckers and sapsuckers occasionally will cause problems by pecking on house siding or a favored ornamental tree. A woodpeckers attention to house siding is usually only temporary. Simply scaring the bird off several times may do the trick or hanging plastic or tinfoil objects from the eaves may be necessary. Reportedly, a chemical preservative called penta, when painted over the area, will repel an inquisitive woodpecker.

Sapsucker damage to pine and fruit trees can be identified as a neat series of ¼" diameter holes circling the tree. Several rows can occur together. To discourage sapsuckers from feeding on a favorite shade tree, wrap hardware cloth or burlap around the area being tapped or smear a sticky repellent material, such as bird tanglefoot on the bark. Bird tanglefoot is often available at tree nurseries.

Bats

Problems with bats are uncommon, but occasionally someone will want to rid an attic or barn of bats. Also, bats will occasionally enter the living area of a building and be trapped inside. Bats are harmless to people and two species, the Indiana Bat and the Gray Bat, are on the endangered animal list. Both are found in Indiana and should be protected.

Barriers

Bat proofing is essential in any bat control program. This can be done before a problem arises, or help eliminate an existing problem. Bats usually enter buildings through unprotected louvers, or vents, broken windows, or other open spaces. It only takes an opening ⅜ of an inch in size to allow some of the smaller species of bats to enter.

If a colony of bats is discovered in an attic or similar area, try to locate the main points of entry. Bats usually begin feeding flights just before maximum night darkness or the late dusk hours. All occupants normally leave the roost within 15 or 20 minutes after the first one leaves. After the last bat has left, close all openings the bats were known to use with sheet metal or ¼ inch mesh hardware cloth if ventilation is desired.

After waiting a couple days, check to see if bats are still using the area. If so, repeat the procedure in the preceding paragraph until the bats are excluded. It is also important to clean-up the bat droppings and deodorize the area, as the roost odor will attract other bats. If after several attempts to locate and block entrances bats are still able to enter, 5-10 pounds of mothballs scattered near a roost has been known to break up roosts.

Shooting and Trapping

At times, the best method of control may be clubbing or shooting with B-B gun, low pressure pellet gun or birdshot in a .22 caliber gun. Shooting is only effective when the bats are roosting during the daylight hours. Poisons are not effective because bats feed primarily on flying insects, which is one of the reasons wholesale extermination is not recommended.

If a bat is discovered inside a living area, close all exits to the rest of the building. Open a door or window to the outside just before dusk. The bat should find the large opening and fly out.

If this doesn't work, the bat must be caught. A fine mesh net could be used, and is easily constructed using a short pole, a heavy wire hoop, and burlap or ladies hose. It may be possible to trap the bat under a small box and slide a piece of stiff cardboard between the box and the wall. Heavy gloves and any other precautions should be used to avoid being bitten.

If this method fails, you may have to resort to clubbing with a broom.

Moles

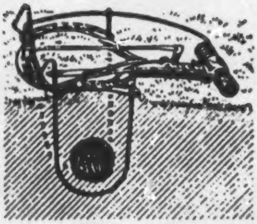
These seldom seen mammals destroy few plants or bulbs by direct feeding. Most damage occurs when plant roots are disturbed as a mole works through the soil looking for earthworms and insects. Damage to plant seeds, roots, and bulbs near mole runs are usually caused by mice and other rodents using the passages.

Trapping

The best time to trap moles is spring and early summer, or shortly after the fall rains. Moles work near the surface when the ground is moist. Two kinds of traps are available to catch and kill moles. Many hardware and farm stores stock them.

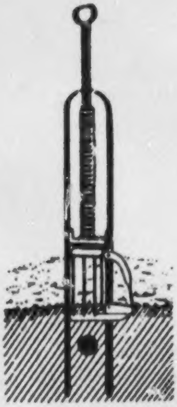
Trapping is more successful if you find the active mole runs. This is done by tramping or rolling the ridges and noting which are raised again. Use a metal rod about ¼" in diameter to probe for the active deeper runways. Deeper runs are more reliable for trapping.

One style of trap is the Choker Trap. These are set by pressing down a small section of runway to make a base for the trigger pan. Then using a trowel, make two slits across the runway far enough apart to allow the trap loops to fit down, encircling the runway. Be sure the loops are at least an inch below the original passage. The trigger pan should be set flush on the ground so that any movement of the soil will trip the trap.



Choker Trap

The Harpoon Trap is used in much the same way. Find an active runway and flatten the ridge. Then insert the flat, pointed supports into the ground, astride the runway. The prongs should be positioned about an inch above the original runway. Setting and releasing the trap several times will allow better penetration into the soil later when a mole sets off the trap.



Harpoon Trap

It is best to reset traps after a rain. Always be sure the trigger pans are properly positioned for a quick response. If nothing is caught within a day, reset the trap in another runway.

Other Methods

Sometimes flooding the deeper tunnels with water will drive a mole to the surface. The mole may then be clubbed.

Some people have reported that decorative whirling daisies are sometimes effective in keeping moles away within ten or twenty feet of the device. It is assumed that the vibration of the whirling daisy somehow distracts the mole so that it is unable to sense it's food moving in the soil. The mole simply moves away from the vibration.

Ground Squirrels (Gophers)

Ground squirrels in Indiana, commonly called gophers, can be chipmunks, thirteen-lined and Franklin's ground squirrels. Chipmunks will cause problems in invading attics or raiding gardens. Thirteen lined and Franklin's ground squirrels become problems when they dig burrows in the yard or garden. Because of their food habits, ground squirrels can become troublesome by digging up newly planted corn and other seeds. The plains pocket gopher, a true gopher, is an endangered species and can be found in limited areas in northwestern Indiana. They should not be destroyed.

Trapping

For that occasional chipmunk that gets into the attic, simply purchase a large wood-base rat trap. Bait the trap with peanut butter, rolled oats or nut meats. Be sure the bait is firmly attached to the trap trigger. Place the trap along a wall or known runway, and if you fail to catch anything in two nights, move the trap to a different location. If you have no success again, try a different bait.

Once the attic visitor is caught, or gone, try to locate all points of entry and cover with metal strips or screen. If your success as a trapper is successfully challenged, naphthalene flakes or moth balls spread on the floor have been known to repel many mammals.

Problems with small numbers of ground squirrels in the yard or garden can be controlled by trapping. A wood-based rat trap baited as explained will work well. Place the trap near the burrow entrance or in the area where damage occurs. A number 0 steel trap baited with similar foods, can also be used. A number 1 live trap, baited and located as above is sometimes effective.

Shooting

Where firearms can be used, a small gauge shotgun like a .410 is preferred to a .22 rifle. For longer shots, the .22 rifle may be necessary. Early morning or late afternoon is the best time to watch for these pests.

Poisoning

This method is suggested only for persistent problems or where other methods are not practical, because of the danger of poisoning children, livestock, pets, or desirable wildlife. Poisoning should only be used by trained, experienced people.

Poison-treated grain can be purchased at hardware and farm supply stores and should be spread near the burrow entrance or near where damage is occurring.

Burrow fumigation with calcium cyanide can be used on ground squirrels. Place a scant tablespoonful inside the burrow and cover the entrance and other holes with sod. Be careful not to cover the chemical with soil. This chemical should be used with extreme caution.

Woodchucks (Groundhogs)

Woodchucks are labeled pests because: their burrows are considered safety hazards, they often burrow under buildings, and because of their fondness for farm crops, especially soybeans. However, people should realize how important a woodchuck burrow is to many other forms of wildlife. The burrows they dig are used by many animals, especially rabbits during winter months.

Spring is the best season to carry out a control program. Young woodchucks have not yet scattered and there is less danger of killing other kinds of wildlife using woodchuck burrows. It's advisable to scout dens you plan to gas beforehand to be sure the den belongs to a woodchuck.

Gassing

The most practical control for woodchucks is the gas cartridge. Gas cartridges are filled with combustible materials and are simply ignited by lighting a fuse. They do not explode and are relatively safe.

They are normally available at a local farm store or hardware. If you cannot locate a source, contact your County Extension Agent.

After lighting, the gas cartridge should be placed as far down the den as possible. A piece of sod, a bit larger than the entry hole, is fitted tightly over the entrance, grass side down. Stand back and watch nearby holes, plugging any hole where smoke escapes. Repeat this procedure until all holes are closed.

Carbon bisulphide will produce a poisonous gas when placed on small wads of cotton or rags, and placed into the entrance of the burrow. Pour about 1½ ounces or three tablespoons on cloth and tightly cover the den entrance. A word of caution: carbon bisulphide is highly explosive and flammable.

Another method of gassing used occasionally is automobile exhaust. This is done by attaching a heavy hose to the car exhaust and placing the free end into the den as far as possible. Pack sod and soil around the hose and all other holes in the immediate area. Exhaust should be piped in for a minimum of 15 minutes.

Shooting

Shooting is another effective method to control "chucks". Many hunters would welcome an opportunity to test their hunting skill against the woodchuck. A carefully aimed .22 rifle can be very deadly, but many feel one of the larger caliber varmit rifles are more effective.

Trapping

For hard to shoot or inaccessible woodchucks, a 220 Conibear trap placed over the den entrance is very effective. If the hole is on a slope, drape the trap over the hole, staked from above. An entry on level ground can be trapped by staking the trap at the side and laying it over the hole. Place the trigger at one side and bend one wire of the trigger toward the center. A number 1½ or 2 steel trap will also do the job when properly placed near the den. Check the traps twice a day and remove as soon as possible to avoid catching domestic animals or other wildlife.

A 220 Conibear Trap set for groundhog

Barriers

For troublesome woodchucks around gardens, any of the above methods will work. However, if you want woodchucks and a garden too, a 2-3 foot high, one by two inch welded wire mesh fence should keep groundhogs out. Be sure to brace the fence securely, and anchor or bury 6-12 inches of fence beneath the ground. If this doesn't work you may want to add single wire electric fence just outside the described fence, about 6 inches above the ground.

Closing

All animals have a value in the natural scheme called Nature and the degree of damage should be weighed against the loss of this wildlife resource. It should be stressed that the most effective animal measure is prevention of the problem. Exclusion of wild animals by proper building maintenance, keeping grounds clear of trash and debris, fencing and periodic inspection of buildings and crops are methods of stopping many problems before they start.

If you have tried the control methods listed in this pamphlet and have met with no success, contact a district wildlife biologist, conservation officer or the local county agen As new chemicals and materials become available, techniques for controlling nuisance wildlife change.

The U.S. Fish and Wildlife Service maintains an Animal Damage Control Office at Entomology Hall, Purdue University, West Lafayette, Indiana 47907. If you need additional information or have an unusually large or severe problem with animal damage, contact their office for assistance. Single copies of leaflets on many species and their control are available free.

The U.S. Fish and Wildlife Service deserves credit for allowing us to use the enclosed drawings and for providing helpful information during the writing of this publication.

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Table. 1. Live Trap numbers, sizes, and size needed for different species.

Trap Number	*Trap Size*	*Recommended for Catching*
0	10x3x3"	Mice, Shrews
1	18x5x5"	Rats, Weasels, Chipmunks, Red Squirrels, Flying Squirrels
2	24x7x7"	Squirrels, Muskrats, Cottontail Rabbits, Gophers
2A	30x7x7"	Large Squirrels, Rabbits, Skunks, Mink
3	36x11x11"	Woodchucks, medium Raccoons, Opossums, Cats
3A	42x11x13"	Large Raccoons
4	42x7x7"	Snakes, large Ground Squirrels, Skunks, Cottontails
7	55x12x12"	Special trap with live bait compartment for Foxes, Coons, small Dogs
10	26x16x8"	Repeating Sparrow trap

Table 2. Jaw-Type Traps, sizes, jaw spread, and size needed for different species.

Trap Size	*Jaw Spread*	*Recommended for Catching*
0	3½"	Rat, Gopher, Weasel
1	4"	Muskrat, Woodchuck, Skunk, Mink
11	4"	Mink
1½	4¾"	Mink, Skunk, Woodchuck
2	4¾"	Fox, Raccoon, Opossum
3	5½"	Coyote, Fox, Beaver
3N	5⅝"	Coyote (trap has offset jaws)
4	5⅞"	Beaver

Table 3. Conibear Traps, sizes, jaw spread and size needed for different species.

Trap Size	*Jaw Spread*	*Recommended for Catching*
110	4½x4½"	Muskrat, Mink, Skunk, Weasel, Rat, Squirrel, Cat
120	4½x4½"	Mink
220	7x7"	Raccoon, Fox, Woodchuck
330	10x10"	Beaver

COMMON WILDLIFE DISEASES AND PARASITES

Management Series No. 11

INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Fish & Wildlife
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COMMON WILDLIFE DISEASES AND PARASITES

by John Russell
Wildlife Management Biologist

Like humans, wild animals are subject to many diseases. Some human diseases, such as colds, flu or poison ivy, are easy to diagnose. Many, however, can only be identified by doctors. The same is true of wild animals. Some diseases are common to a certain species or show characteristics which the average person can recognize. Other diseases and parasite problems can only be diagnosed by a veterinarian.

Death by disease is a natural occurrence and plays an important role in wildlife ecology. When wild populations are allowed to increase in numbers beyond what the land will support, disease outbreaks often kill many animals. This is a natural phenomena and results in the survival of only the stronger or more resistant animals. These individuals, will in turn, be the parents of young which will inherit the most desirable traits necessary for survival.

Wildlife, like humans, are subject to accidental injuries such as wounds, bites, broken bones and loss of limbs. Accidental injuries may result in abnormal appearance or strange behavior suggestive of disease. Injured wildlife, especially the prey species, seldom survive in the wild for long and rarely can be saved by treatment. Injured animals should be left in the wild and allowed to succumb to natural predation.

The purpose of this publication is to help the average outdoorsman recognize many of the wildlife disease and parasite problems encountered in Indiana. Public recognition of disease or parasite problems should help reduce unwarranted fear of contracting a wildlife disease and reduce wastage of wild meat taken by hunters.

Bacterial Infection In Muskrats

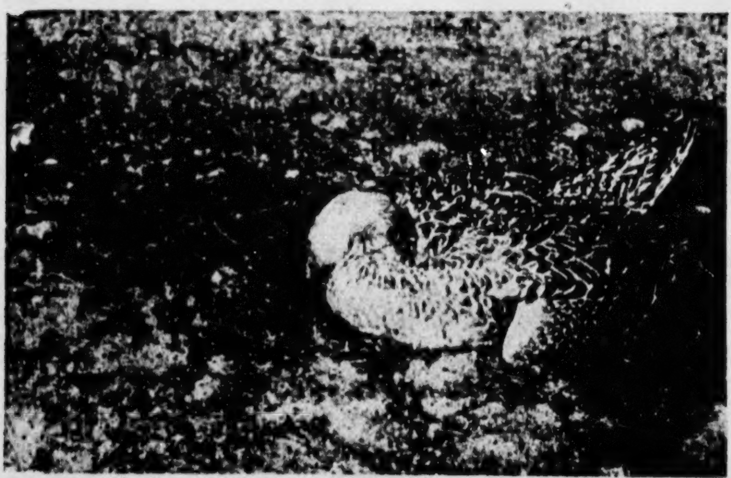
This disease occurs in areas where there are high concentrations of muskrats. Although this infectious disease is caused by bacteria commonly found in wetlands, it is a result of overpopulation. As the muskrats compete with one another for living space, there is a great deal of fighting. The open wounds caused by fighting are sources for infection by bacteria.

Symptoms of the disease are large, pus filled swellings around the throat and chest region. The condition is fatal and when muskrats are allowed to overpopulate, this disease serves as one type of natural control.

Muskrats showing pus filled swellings around the throat are victims of a bacterial infection.

Botulism

This disease can affect many animals, including man, but in the wild is usually seen in waterfowl. Botulism is caused by poisons produced by strains of bacteria which are widely distributed and normally found in the soil. The bacteria can grow in dead fish, birds, animals and plants if conditions are suitable. There are several types of poisons produced by the bacteria, one of which is the most poisonous substance known to man.



A hen mallard showing loss of muscle control—the best field symptom of botulism.

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Waterfowl that are poisoned lose muscle control. In some instances the head falls into the water and the bird drowns. Birds not in the water may die from respiratory failure, starvation, predation or dehydration. When the proper environmental conditions are met for the growth of this bacteria, large die-offs can occur in a relatively short time period.

Situations favorable to botulism poisoning can be natural or man-made. Fly larvae feeding on animal carcasses build up high levels of the toxin which may kill birds feeding on the flies. Waste grain or feed, allowed to accumulate and rot, are ideal botulism factories that can cause die-offs in domestic and wild birds. Though the disease occurs under natural conditions, it is often a result of unsanitary conditions caused by man.

Newcastle Disease, Avian Chorlera and Duck Plague are other wildlife diseases that can cause die-offs in waterfowl populations. Often the external symptoms are similar to botulism and lead poisoning and diagnosing large die-offs should be left to a veterinarian or wildlife biologist trained in diseases. Contact the Indiana Department of Natural Resources if any of the diseases are suspected in waterfowl deaths or if a number of dead waterfowl are encountered.

Distemper

In addition to the domestic dog, distemper affects raccoon, red and gray fox, coyote, mink, badger, weasel and skunk. The disease is caused by a virus and is transmitted from one animal to another by direct contact. The virus is contained in discharges from the nose and eyes of infected animals.

Symptoms in raccoons include pus around the eyes and nasal discharge. Most conspicuous is abnormal behavior which sometimes is suggestive of rabies and pseudorabies. This behavior includes fearlessness, aggressiveness, disorientation and lack of alertness. There is often twitching and convulsive movements of the head and paws along with aimless wandering. Some animals show weakness and loss of weight.

The time from the initial infection until stymptoms show is 8 to 20 days and the duration of the illness is 2 to 10 days. Although recovery rate varies by species and age of the infected animal, at least half of the cases probably result in death.

Distemper is much more common than rabies or pseudorabies and large die-offs of raccoons are usually seen in areas the size of a township or smaller. Apparently the animals all contact the disease at about the same time as these die-offs usually occur and are over in a 3 to 4 week period.

Distemper is a disease that helps control overpopulation of wild animals. Wild animals showing symptoms of the disease should be destroyed to help prevent the spread of distemper.

Fleas-Lice

Fleas and lice are common parasites on many wild animal species. Severe infestations of these small insect-like creatures can cause skin irritations that promote rubbing and subsequent loss of hair. The symptoms will often resemble mange in extreme cases. These parasites are seldom numerous enough to cause the animals death, but can lead to a weakened condition and death by predation or secondary causes.

Rabbit hunters frequently see large numbers of fleas on rabbits taken early in the season. As the carcass cools, the fleas leave the fur and are extremely visible. They will not live on the human body and in no way contaminate the meat of the game species. Hunters should not discard rabbits or other game because of the presence of external parasites.

Lead Poisoning

Lead poisoning is a disease which affects waterfowl. Ducks and geese pick up lead shot while feeding in areas where a great deal of hunting activity has taken place. The lead shot usually stays in the gizzard where the normal grinding action slowly breaks the metal down. When the lead is broken down, minute particles enter the blood stream. Lead interferes with normal body chemistry and digestion of food is incomplete.

An abundance of lead shot can be seen in this goose gizzard.

Symptoms include severe loss of body weight as a result of the bird not being able to digest food properly. The wings tend to droop and ultimately the birds are unable to walk or fly. Many ducks and geese which die as a result of lead poisoning are not found. In a

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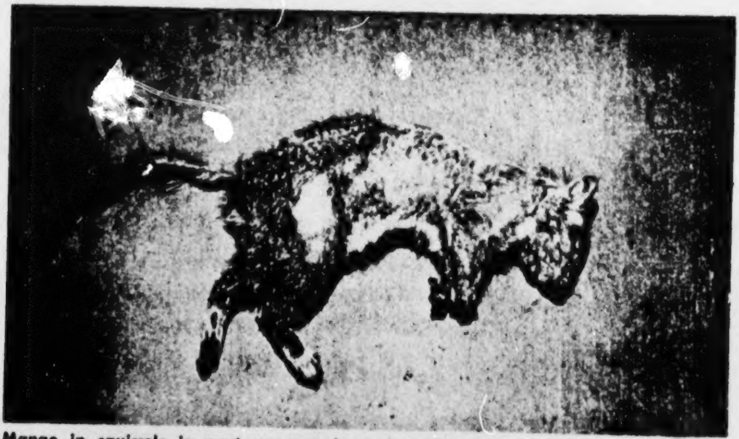
weakened condition, they seek isolation and often are consumed by predators or scavengers.

As this disease is a bio-chemical problem caused by ingesting a poison (lead), it is not contagious. The solution to reducing the loss of waterfowl to lead poisoning is the use of non-toxic shot when waterfowl hunting. Steel shot is now available and other alloys may be developed in the future.

Mange

Mange is a fairly common disease of wild and domestic animals and is most often seen in dogs. Although mange affects many different animals including raccoons and coyotes, it is most prevalent in foxes and squirrels in this state.



Mange in squirrels is most common in early spring and is often associated with squirrels in urban areas.

Mange is a general term applied to a group of contagious skin diseases caused by minute size, insect-like parasites called mites. Chiggers are a mite that cause humans the most discomfort. Mites burrow into the skin of animals and cause intense irritation and itching. As the animal rubs the affected area, blisters and small lumps and ridges develop. The skin becomes swollen and inflamed and the rubbing causes a rupture and discharge of serum. The serum mixes with foreign matter, dries and forms scabs. The mites constantly move from the edges of the lesions to the surrounding healthy skin and the condition spreads over the body.

Symptoms include patchy to complete loss of hair, scabs and skin secretions. The skin also appears to have crusts which show cracking. In the case of squirrels, loss of hair usually begins on the ears. The disease is spread to other animals by direct body contact or through the use of common rubbing posts used to relieve the itching. In addition to the external signs of mange, animals bite and rub extensively, may stagger and will not run far when approached. Mangy animals are seldom as heavy as healthy ones.

An extreme case of mange in a young fox.

Mange is generally most common in the early spring. Animals are in their worst physical condition of the year due to winter stress and the mange condition is worsened by long periods in dens or burrows. Mangy wildlife should be destroyed to help prevent the spread of the disease.

Rabies

Although all warm blooded mammals are capable of contracting rabies, the stripped shunk is the most important wild carrier in Indiana. Between 1965 and 1975, skunks made up 61 percent of the total confirmed records of animal rabies. Foxes followed with 6 percent of the cases and the remaining 33 percent were both wild and domestic animals with dogs leading the list. Bats are frequent carriers of rabies but have limited contact with humans. In the same 10 year period, there were no confirmed cases of human rabies in Indiana according to the Indiana State Board of Health records.

Rabies is caused by a virus which affects the nervous system. The virus is transmitted in the saliva and is usually passed from one animal to another by biting. It can also be transmitted by saliva contact in a break in the skin. The time from initial infection until symptoms appear is variable and can range from 10 to 240 days. However, most cases develop within 3 months. The disease ends in death but not all rabid animals transmit the disease and not all animals bitten by an infected animal contract the disease.

Infected skunks and other animals often are restless and show no fear of humans. These animals are usually active only at night, but when rabid are seen about during the day. The animals will approach people and buildings and are frequently aggressive.

Symptoms of another form of rabies are partial paralysis of the lower jaw and salavia dripping from the mouth.

The sumptoms of rabies are similar to distemper and several other diseases. A laboratory analysis is necessary for positive identification. Wild animals showing these symptoms should be destroyed to help prevent the spread of the disease. Where humans or livestock have had contact with an animal having symptoms of rabies, the county health officer should be contacted before the animals are handled. If the animals are shot, they should not be shot through the head as the brain is needed for diagnosis. The head can be shipped or delivered to the State Board of Health for diagnosis.

Skin Tumors

Several types of skin tumors are occasionally found on white-tailed deer, squirrel and rabbit. The tumors are the result of a virus infection. The most common is the papilloma or wart found on deer. The tumors are benign (non-cancerous) and can be transmitted to other deer but not humans.

The warts are usually found on the head and neck region of deer, but can be found on other parts of the body. These tumors vary in size and are usually a light gray to black in color. They are dry and resemble cauliflower in appearance, being attached to the skin by a short stalk.

The papilloma or wart is non-cancerous and cannot be transmitted to humans.

There are other types of skin tumors found on white-tailed deer, but generally speaking, they are non-cancerous. Although tumors may detract from the over-all appearance of the animals, they seldom affect the health and vitality of the carrier.

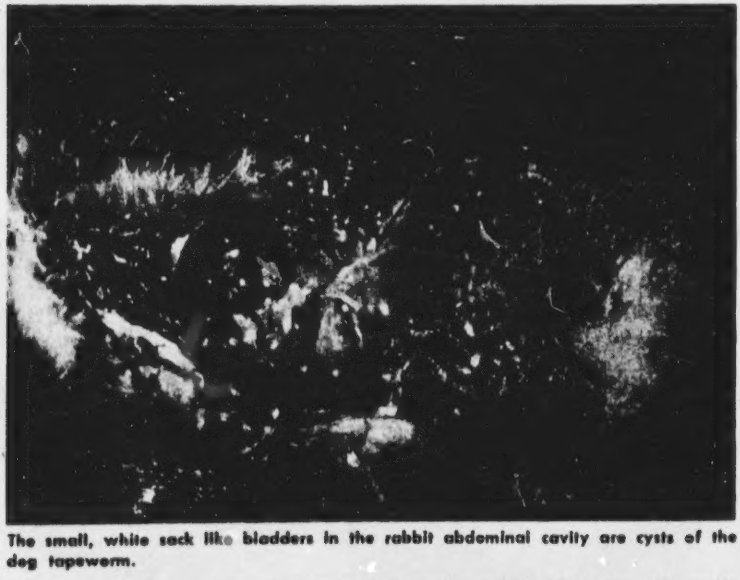
The tumors are removed in the normal cleaning operation of deer, rabbit and squirrels taken by hunters and will not affect the edibility of the meat.

Tapeworms

Many mammals, wild and domestic, are hosts for various species of tapeworms. Three types of tapeworm may be observed when cleaning wild game.

Adult tapeworms are commonly found in the intestinal tract of rabbits and squirrels. Occasionally hunters report tapeworms in the body cavity but this results from a puncture of the intestine wall and the subsequent movement of the tapeworm. The presence of tapeworms, unless heavily infected, does not affect the health or vitality of the animal and should not detract from the edibility of the animal.

The cyst of the dog tapeworm is almost always found in the abdominal cavity of rabbits. These appear as clear, sack-like bladders about the size of a pea. In extreme cases, it may resemble cottage cheese and be concentrated in the anal area. The edibility of the meat is not impaired as a normal cleaning operation while field dressing will remove the cysts. The tapeworms are transmitted to domestic dogs,



The small, white sack like bladders in the rabbit abdominal cavity are cysts of the dog tapeworm.

foxes or coyotes when they eat the infected animals so hunters should burn or bury the entrails from the infected animals.

A third tapeworm found in rabbits and squirrels and occasionally seen by hunters is characterized by much larger cysts and is found under the skin or between layers of muscle. Although proper cooking would render this parasite harmless to humans, most hunters prefer to discard the carcass.

Tularemia

Many species of wildlife can be affected by tularemia. The disease has been found in muskrat, beaver, deer and other animals but the cottontail rabbit remains the most common victim in Indiana and most other states. It is for this reason that the disease has been called "rabbit fever".

Tularemia is caused by a bacteria and is usually transmitted from one animal to another by ticks, mites, biting flies or fleas. Rabbits infected with tularemia are not likely to run as rapidly as normal. Often in advanced stages they will appear to be in a stupor. An internal examination may show tiny pin-point size, white spots on the liver. The liver and spleen may also be a dark bluish red color and be enlarged. Unfortunately other diseases and internal parasites can cause organ conditions similar to the effects of tularemia so a casual examination can be misleading.

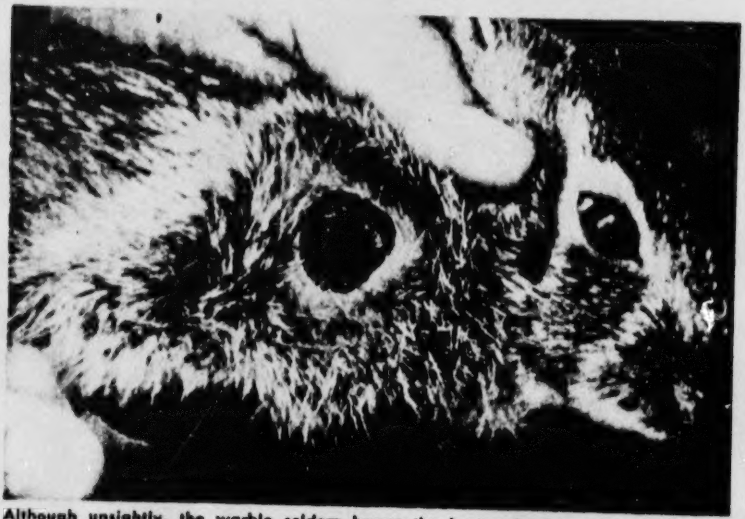
Between 1965 and 1975, the Indiana State Board of Health reported an average of only four cases of human tularemia a year. Considering the tens of thousands of rabbits harvested every year by hunters, the chances of a human contacting the disease is very small. Although humans can contract "rabbit fever" by touching infected animals, eating insufficiently cooked meat, or from ticks, mites, flies or fleas, the disease is easily controlled by antibiotics. Some cases may go unreported in humans because it simply "runs its course" or is treated like any other bacterial infection.

This plague-like disease will periodically cause large die-offs of rabbits. In areas with a large rabbit population, the die-off is much more noticeable. In recent years the greatest economic loss from tularemia has been the meat wasted by hunters because of an unfounded fear of contracting the disease.

Warbles

Domestic animals and several species of wildlife can be hosts for warbles. In Indiana these parasites are most commonly found on cottontail rabbits and squirrels.

Large bot flies are responsible for the parasitic warble. The adult flies lay eggs in areas frequented by rodents and rabbits. These eggs in turn hatch into grubs (larvae) which attach to the animals and burrow under the skin. It is this stage of the bot fly that causes the swelling associated with warbles. Development lasts a few weeks after which the grub will leave the swollen skin area through a breathing pore and complete its life cycle in the soil.



Although unsightly, the warble seldom harms the host animal or contaminates the meat.

Warbles are usually found in the groin and neck region of rabbits and squirrels but can occur on other parts of the body. These swellings under the skin are about the size of a lima bean and can show pus. If the swollen area is opened, a small grayish white to dark brown or black grub can sometimes be found. Usually there are no symptoms in free ranging animals. Unless infestation is extremely heavy or the infected animal is very young, mortality to the host seldom occurs.

Warbles are commonly found during early fall on rabbits and squirrels harvested by hunters. Occasionally the meat is blemished in a small area below the skin swelling but this is easily removed during normal cleaning operations. The meat is entirely safe for human consumption and affected animals should not be discarded.

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ABC's of Hunting

These ABC's are not rules, but just reminders. And whether you are and old or new hunter, they are worthy of your attention.

Always practice safe gun handling

Be considerate of the landowner. You are his guest

Conduct yourself as a SPORTSMAN should.

Don't be a game hog.

Educate youth in the principles of sportsmanship.

Favor the fellow who is hunting with you.

Give wildlife a break. Work for its conservation.

Have the location of your hunting partner always in mind.

Influence others to hunt safely.

Join a sportsman's organization.

Keep that gun muzzle elevated.

Leave some game for seed stock.

Make sure of your target before you shoot.

Never leave a cripple to go to waste.

Obey the game laws to the letter.

Put yourself in the other fellow's place. Treat him accordingly.

Quit harping about game shortages and do something about it.

Retrieve every piece of game you knock down.

Share your game with the farmer.

Take a boy or girl, other than your own, hunting or fishing.

Unite your fellow sportsmen in a common effort to provide better hunting and fishing.

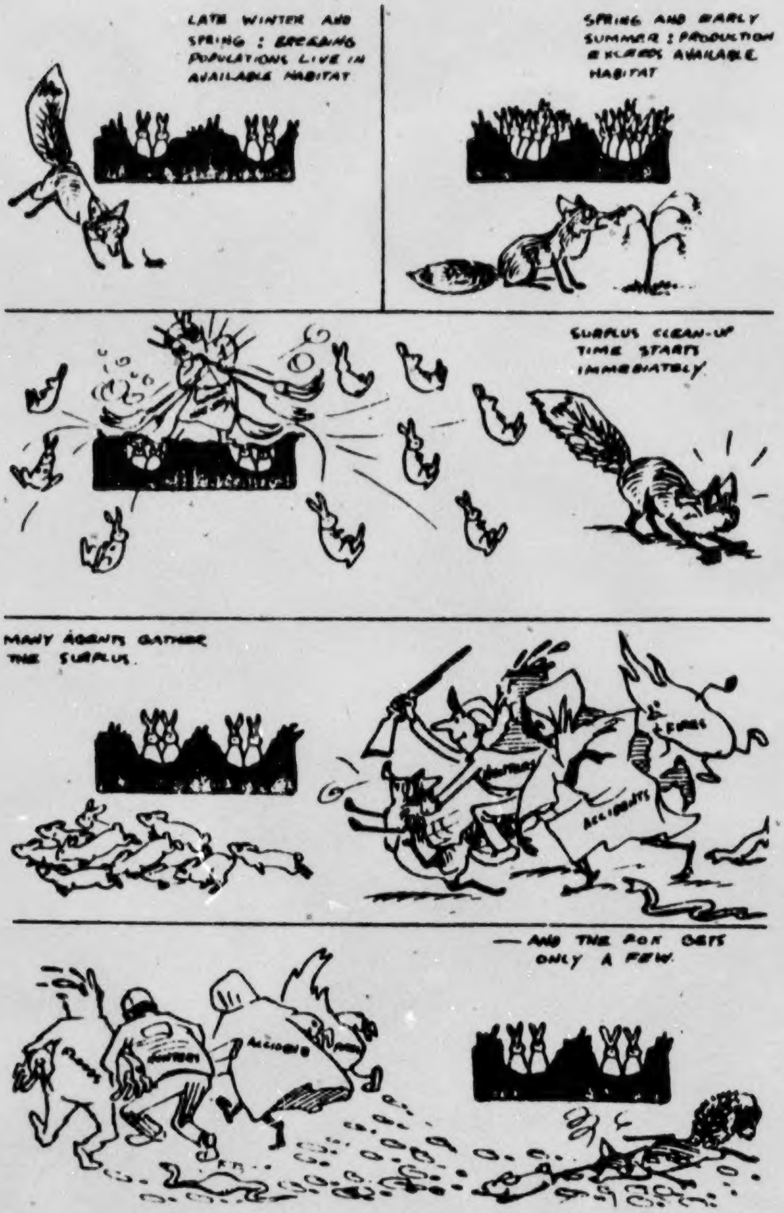
Value and protect your right to own and bear firearms.

Work for all wound game management measures.

X may mark the spot if you mix gun powder and alcohol.

Young America's future field sport depends on YOU.

Zeal in game restoration activities will pay big dividends.


LATE WINTER AND SPRING : BREEDING POPULATIONS LIVE IN AVAILABLE HABITAT
SPRING AND EARLY SUMMER : PRODUCTION EXCEEDS AVAILABLE HABITAT
SURPLUS CLEAN-UP TIME STARTS IMMEDIATELY
MANY AGENTS GATHER THE SURPLUS.
ACCIDENTS
— AND THE FOX GETS ONLY A FEW.
ACCIDENTS

NATURAL WILDLIFE PROBLEMS

BIRDS IN YOUR BACKYARD

by Chuck Danner , Wildlife Biologist

Interest in attracting wild birds is growing continually. More and more people are finding great enjoyment observing these colorful and interesting backyard visitors. Many who would like to attract wild birds to their yards just don't know how to do it. If a few simple things are known, the newly interested bird watcher should have no problem attracting birds to his home.

Wild birds needs are simple. They need only food, cover, and water. The food they need depends on the kind of birds they are. Seed eaters, fruit eaters, and insect eaters are normally found around homesites. Cover needs also vary for the different kinds of birds and for the different seasons. The basic thing to remember, though, is that all three, food, cover, and water, need to be close together and intermixed.

A variety of wild bird seed is available from numerous commercial sources. Either a mixture, including such seed as millet, sorghum, and sunflower, or straight sunflower seed is normally available from the local grocery, drugstore, or grain elevator. Such seed will attract many kinds of birds whose diet consist either partly or entirely of seed. This includes such birds as the titmice, nuthatches, chickadees, cardinals , bluejays, and many more.

There are several ways the seed can be made available to the birds. Bird feeders are most commonly used, but seed can be spread on picnic tables, window sills, or even on the ground. Bird feeders come in as many sizes and shapes as there are people who make them. Some have automatic hoppers which continue to let out seed as the birds remove it. Others have to be filled daily. More important then the actual design of the feeder is its location. Birds will come most readily to a feeder which is in a protected area, out of the full blast of the wind, away from undue noise and disturbance, and protected from predators.

It must be remembered that once birds become accustomed to a feeding station, they may become dependent on it. Once dependent upon the feeder, if it isn't kept full birds could starve to death during long periods of snow and ice cover.

Fruit eating birds are also easily attracted. Cut apples and oranges, currants, raisins, and bread crumbs will bring birds like mockingbirds, catbirds, thrashers, and robins. Another way to attract these birds is by planting fruit bearing shrubs. A variety of shrubs are available from several sources including inexpensive seedlings from the state nurseries. A few shrubs to consider are autumn olive, red osier and silky dogwoods, amur honeysuckle, staghorn summac, flowering crabapple, and flowering dogwood.

Fruiting shrubs are also usefull to the birds as cover plantings. Evergreens are another excellent cover planting to make a backyard more attractive to birds. Birds use the cover plantings to nest in, hide in, loaf in, and roost in. Elaborate landscaping is not necessary as simple plantings will do just as well.

While evergreens and shrubs are important, open spaces are needed also. Openings allow plenty of light to reach the plants making for better growth and more fruit and seed production.

Nothing is more attractive for birds during hot weather than drinking and bathing places. Water can be provided in flowerpot saucers or other small receptacles, but in these it must be frequently renewed. A larger bird bath is better. It should be shallow readily cleanable, and easy to refill. Water will also readily attract birds in the winter. Water in the winter must be kept warm or running to prevent it from freezing.

Another easy and interesting way to attract birds is by providing nesting sites. Purple martins are a favorite with many bird watchers. Not only do they readily nest in multiple apartment houses but they also eat many thousands of mosquitoes thus making the backyard a little more livable. Blue birds are also prone to using nesting boxes and make an interesting and colorful addition to anyones backyard bird family. Wrens and many others can also be encouraged to nest around homesites.

All a person really needs to do is provide a little food and cover and he can fill his yard with bright and cheery feathered visitors. Just remember to keep the feeder and bird bath full. A word of caution, though, don't feed peanut butter to the birds. Many will readily take it, but some will occasionally choke to death. Once the feeder is full and the shrubs have been planted, sit back with a good bird book and learn the birds and their habits as they visit your backyard.

LESSON 14: FISHERIES AND FISH MANAGEMENT

OBJECTIVES:

At the completion of this lesson the student will be able to:

1. Define fish management.
2. Describe how fish management is accomplished.
3. Define what a lake survey is.
4. List five techniques used for conducting fish management.
5. List the answers to the 15 questions in the handout entitled, "What You Ought to Know About Fish Management."
6. List three things that is happening to our stream fisheries.
7. List why there are fish killed in lakes and ponds.
8. Write a paragraph explaining where the money used to purchase fishing licenses goes.
9. Define the effect of fishing on fish populations.

MOTIVATION:

1. How many of you like to fish? Why? See transparency master, "Trends in angling participation."
2. What would happen if in your favorite fishing stream all the fish suddenly died?
3. Have the students comment on the following statement made by former United States President Herbert Hoover.

   > "There is something about the rippling of a brook and the slapping of waves against the boat that will brainwash most anybody into a much cleaner frame of mind."

4. Is fish management important?

REFERENCES:

Patterns for Preservation, National Farm Book Company.

Transparency masters: "Trends in Angling Participation"
"The Effect of Fishing on Fresh Water Populations"

Handouts: "Indiana Warm Water Fish Management," Indiana Department of Natural Resources, Division of Fish and Wildlife
"Lake Surveys--A Valuable Source of Fishing Data", Indiana Department of Natural Resources, Division of Fish and Wildlife
"Lake Restoration with Chemicals--A Valuable Fish Management Tool", Indiana Department of Natural Resources, Division of Fish and Wildlife
"Fish Stocking - Indiana Style", Indiana Department of Natural Resources, Division of Fish and Wildlife
"What You Ought to Know About Fish Management", Copyright Outdoor Indiana, 1977
"What Causes Fish Kills in Indiana," Indiana Department of Natural Resources, Department of Fish and Wildlife
"Fish Kills in Indiana--Their Causes and Prevention", FNR-69, April 1977, Coop Extension Service, Purdue University
"Your Fishing License Money at Work", Indiana Department of Natural Resources, Division of Fish and Wildlife
"What's Happening to Our Stream Fisheries?" Indiana Department of Natural Resources, Division of Fish and Wildlife

Film: Headwaters, Location Purdue A.V. Center

OUTLINE:

A. Fish Management:

Fish management means manipulating fish populations to provide the best sport fishing possible with today's fishery knowledge. (This definition is included in the handout, "Indiana's Warm Water Fish Management.")

B. Fish Management is accomplished by first conducting a lake survey and then by putting fish management techniques into practice. See handout, "Indiana's Warm Water Fish Management".

C. A lake survey is a scientific examination of a lakes physical, chemical and biological characteristics. See handout, "A Valuable Source of Fishing Data--Lake Surveys."

D. Five Techniques for Conducting Fish Management:

1. Habitat improvement.
2. Selective and partial eradication, see handout "Lake Restoration with Chemicals."
3. Total eradication, see handout "Lake Restoration with Chemicals."
4. Supplemental stocking--see handout "Fish Stocking--Indiana Style."
5. Leave a stream or river natural.

E. Fifteen things that "You Should Know About Fish Management." See handout, "What you Ought to Know About Fish Management" for the questions and answers.

F. Things that are Happening to our Stream Fisheries:

1. Pollution
2. Channelization
3. Habitat disappearing

   See handout, "What's Happening to our Stream Fisheries?"

G. Why There are Fresh Kills in Indiana Lakes and Ponds. First realize though that fish need oxygen in the water to live.

1. In the spring, fish are in their poorest condition of the year. Food intake has decreased over the cold winter months resulting in weight loss. Extra stress is placed on the fish as algae begins to grow and decompose in early spring. This causes a decrease in the oxygen level of the water. Larger fish, because of their greater need for oxygen, are often the first to die from oxygen shortage, followed by the smaller fish.

   Spring kills are most common in lakes with slow-growing, stunted fish population. Fish in good physical condition at the start of winter are better able to cope with harsh winter conditions and thus are in better shape come spring.

   Spring kills cannot always be prevented, but treatment of early growths of algae can help.

2. In summer, decomposing algae is the most frequent cause of fish kills. The fast-growing algae may cover an entire lake in only a few days. There may be a rapid die-off of the plants after a cold rain or after several days of cloud cover. When this occurs, photosynthesis and oxygen production stops and decomposition of

the algae further reduces the oxygen level. Treatment of algae before it becomes a problem is the best preventive measure.

3. In winter, a lake's oxygen level is dependent on the passage of light through the ice. The sunlight works in cooperation with tiny aquatic plants to produce dissolved oxygen. If the surface ice is cloudy or snow-covered, sunlight cannot penetrate it. Oxygen production stops.

   Without this constant replenishment of oxygen, the combination of fish's respiration and decomposing organic material may reduce the oxygen content to intolerable levels. Cutting holes in the ice is no help. The only worthwhile measure is to remove the snow from the ice. Snow-covered ice is particularly harmful to fish in shallow, fertile, weed-filled ponds.

4. See handout, "What Causes Fish Kills in Indiana's Lakes and Ponds?"

5. See handout, "Fish Kills in Indiana--Their Causes and Prevention."

H. Fish License Money Goes for:

1. Fishery biologists' salary.

2. Fish surveys.

3. Fish hatchery programs.

4. See handout, "Your Fishing License Money at Work."

I. The Effect of Fishing on Fish Populations:

1. See transparency master, "The Effect of Fishing on Fish Populations."

TEACHING LEARNING ACTIVITIES:

1. Have students each write a definition for the management of fish.

2. Review the answers to the class's definition of fish management. Ask the class why fish have to be managed. Look for answers like: To create balance in game fish populations, and to provide catchable sized fish for the state's fisherman. To provide a healthy environment for fish, etc.

3. How is fish management accomplished? Provide students with the handout, "Indiana Warm Water Fish Management". Provide students with a question sheet to aid in review and discussion.

4. Tell the students that you would like to know the fishing conditions for a particular lake in the area. Ask the students who you should ask. (fisheries, biologist) Have the survey available for discussion. How does the biologist determine the general lake conditions? Provide the handout, "Lake Surveys--Available Source of Fishing Data."

5. Provide the students with the handouts on"Lake Restoration with Chemicals" and "Fish Stocking--Indiana Style." Discuss the methods used to conduct fish management.

6. What are some problems that might disturb a stream fish population? Allow students time to answer this question in writing. Discuss the handout, "What's Happening to Our Stream Fisheries?"

7. Ask students if they have noticed large numbers of fish dieing in their home pond or a lake or pond in the community. Have them discuss how such a problem might occur. Relate the discussion to the outline section on fish kills, and the handout on "What Causes Fish Kills in Indiana Lakes and Ponds."

8. Discuss how all of the fish management activities are financed. Pass out the materials, "Your Fishing License Money at Work."

9. Show the transparency, "The Effect of Fishing on Fish Populations," and refer back to the handout, "What You Ought to Know About Fish Management."

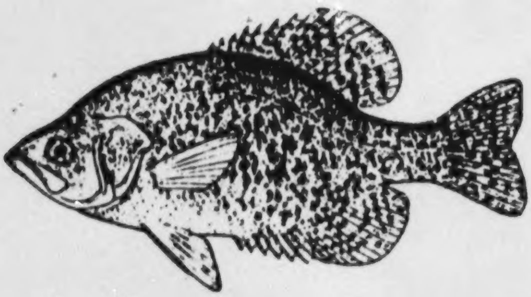
10. Ask the District Fisheries Biologist to supply management equipment and a discussion of what is involved in sampling a fish population. (Exhibit gill nets, shocker boat, depth finder, sechii disk, water quality sampling kit.)

    Alternate - see if water quality analysis demonstration could be run during a field trip to a lake or pond to give class an idea of the chemical make-up of it and how dissolved oxygen varies at different depths.

11. Show the class the movie, Headwaters. This movie discusses the upper reaches of streams. It features the smallmouth bass showing how these fish live and die in a small headwaters community. Location-Purdue University A.V. Center, Shelf No. MP3151. This film is strongly recommended.

SUGGESTED EVALUATION:

1. Give students a quiz over the objectives.



INDIANA'S WARMWATER FISH MANAGEMENT

Fish management means manipulating fish populations to provide the best sport fishery possible with today's fisheries knowledge.

Fish management in Indiana is conducted by professionally trained fisheries biologists who received their training from universities which offer some of the best fisheries education in the country.

In Indiana fish management is accomplished by first conducting a fisheries survey and then by putting fish management techniques into practice.

A survey enables the biologist to evaluate the condition of the fishery, the age of the fish and the species which will be managed. After an evaluation is made the biologist has several means at his disposal for management. They are partial drawdowns, habitat improvement, selectives, partial eradication, total eradication and supplemental stocking or any combination of these which the biologist believes will improve the existing fishery.

The most misunderstood fish management tool is supplemental stocking. The public still believes that supplemental stocking means the biologist runs around the state stocking every species of fish known to occur in Indiana from the back of a hatchery truck.

This is not the case! Reservoirs, lakes and ponds in Indiana are only stocked once with largemouth bass and bluegill. The natural reproduction from this one stocking will maintain the fishery and provide all the fish any angler can catch. The trick is to manipulate those reproducing populations so a desirable sport fishery is produced. This is where the fisheries biologist enters. It is the biologists' sole responsibility to manipulate fish populations and provide Hoosier fishermen with a desirable catch.

Supplemental fish stockings are only conducted where fish populations cannot reproduce naturally. This is usually the result of inadequate habitat. Several species which fall in this category are channel catfish, walleye and northern pike. If a lake or pond is managed by the state and has either of these species, the chances are they are there because the biologist stocks those species on a regular basis.

A good fish population and a good days fishing go hand-in-hand and neither occur by accident. Today Indiana's fisheries biologist is a well-trained professional who can produce a quality fishing experience for the Hoosier angler.

INDIANA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FISH AND WILDLIFE

A Valuable Source of Fishing Data

LAKE SURVEYS

By Gary Hudson
Regional Fisheries Biologist

Catchin' any? Enysizetoum? Indiana's eighth District Fishery Biologists are asked these questions each week throughout the Summer when they are conducting lake surveys.

A lake survey is a scientific examination of a lake's physical, chemical, and biological characteristics. Indiana biologists survey approximately 100 lakes annually. These data are used to inform Hoosier fishermen of the best fishing lakes. But more importantly they serve as the basis for sound fish management recommendations that will ultimately produce better fishing.

Let's get in the boat with the Fishery Biologist and help him survey Big Fish Lake. This is the first survey of Big Fish Lake and our objective is to determine the condition of the fish population. If the fishery is a good one it will be promoted through the news media. If a poor fishery exists, the survey data will serve as the basis for making recommendations to improve fishing.

A State-owned Public Fishing site located on the lake's North shore places Big Fish Lake high on the list of the waters to be surveyed. Public access and potential benefit to the angler are two criteria used to establish lake survey schedules. Indiana Department of Natural Resources biologists concentrate their efforts on public waters and do not survey private waters.

A look at the map prior to leaving shore shows the bottom contours, maximum depth, inlets, outlets, surface acreage, volume of water and location of the water level control structure.

After motoring to the deepest area of the lake and anchoring the boat we'll check those physical and chemical characteristics of the water that are most important to fish. After all, water is the fish's home.

Lakes vary considerably in the production of fish food organisms and fish because of differences in physical and chemical conditions from lake to lake.

PHYSICAL CHARACTERISTICS

Water temperature is one of the first characteristics to be checked. Temperatures are taken every two feet from the surface to the lake bottom. All species of fish have preferred temperatures. However, most fish can tolerate a wide range of temperature. Water temperatures should not exceed 85° for optimum feeding and growth of any warmwater game species. Certain species of coldwater fish (Trout, Salmon) are quite specific in their temperature requirements. Summer temperatures for coldwater species should not exceed 70°.

Water clarity is important because plants produce oxygen only in the presence of Sunlight, and oxygen is vital to all aquatic life. Water clarity determines the depth to which light penetrates. Also, fish such as Largemouth Bass and Northern Pike which feed primarily by sight will grow faster in clear water than in turbid water. Water clarity is measured by lowering an eight-inch-diameter black and white secchi disk into the water and recording the maximum depth at which it can be seen. Generally speaking, the clearer the water the better its quality.

Oftentimes water clarity is low because of large concentrations of microscopic plants and animals or heavy silt loads resulting from poor land use practices. When the secchi disk reading is low——less than three feet——biologists try to determine what is causing the turbidity. After checking other lake conditions they will be able to formulate recommendations for making the water clearer.

Classification of bottom material is important, since bottom type affects the overall productivity of a lake. Lakes in good farm country where the soils yield large crops grow more pounds of fish than lakes in poor soil areas. A lake is no more fertile than the surrounding soil.

Bottom materials affect the type and amount of fish food organisms that grow, in addition to serving as spawning ground for fish. Walleye and Smallmouth Bass prefer gravel and rubble for spawning. Bluegill, Largemouth Bass, and Catfish will spawn on practically every bottom type, including muck, sand, marl, gravel, and clay. Northern Pike require large shallow areas of grassy vegetation on which to deposit their eggs. Classification of the type and amount of the different bottom materials provides an index of available spawning habitat.

CHEMICAL CHARACTERISTICS

The amount of dissolved oxygen present in a lake is very important. It indicates the suitability of the water for sustaining life. Fish, and the organisms on which fish feed, require dissolved oxygen. Warmwater fish require five parts per million (ppm) dissolved oxygen. Trout require seven to eight parts per million. Most Indiana lakes stratify in mid-to-late Summer. This results in a layer of warm water containing oxygen resting on top of a layer of cold water that's low in oxygen and unsuitable for fish. The warm upper layer is lighter than the deep cold water. Therefore little mixing occurs and fish are restricted to the oxygenated zone.

To determine if a lake will support Trout, water temperatures and dissolved oxygen concentration are measured in August or September, the time of the year when water quality is poorest. Trout not only require water colder than 70° but this water must also be high in oxygen. Practically every lake has cold water in its deepest area but few lakes have a layer of cold water high in oxygen.

Total alkalinity, (a measurement of chemical nutrients, particularly calcium carbonate) provides another index of a lake's ability to produce fish. Lakes where total alkalinity measures less than 50 parts per million are classified as unproductive because the pounds of fish produced is low. The total alkalinity level of most Indiana lakes is within the range of 50 to 200 parts and these lakes are capable of producing a relatively large crop of fish.

pH, a measure of acidity, aids the biologist in detecting areas of pollution such as acid stripmine drainage. It is generally agreed that for good game fish production, pH values should remain between 6.5 and 8.5.

BIOLOGICAL CHARACTERISTICS

Before collecting fish, which is the most exciting part of the survey for fishermen and biologists alike, let's list the type and abundance of macroscopic aquatic vegetation. Macroscopic vegetation includes all plants that can be readily identified without the use of a microscope.

The identification is important of the grass-like rooted plants that grow below the waters surface, such as filamentous algae (moss), water lilies, cattails, etc. Too many macroscopic plants can be detrimental to a fishery. They provide unnecessary protection for small panfish and utilize nutrients that would otherwise be available for plankton growth. Another important consideration is that dense weed growth makes it difficult for fishermen to fish. Weed control with an aquatic herbicide is usually recommended when aquatic vegetation covers more than 25% of the lake.

COLLECTION METHODS

Fish are collected by gill nets, trap nets, electro-fishing, and seining. It is important to use different methods when sampling fish, as each method is effective for certain species.

Yellow Perch, Crappie, White Bass, Walleye, and Gizzard Shad can be captured with gill nets. Gill nets, 250 feet long and six feet deep, are fished at various depths throughout the lake so that fish in all areas of the lake are sampled.

Trap nets set in the shallow shoreline areas are effective in collecting Bluegill, Walleye, Northern Pike, Catfish, and Crappie.

Seining the shoreline during August or September is an effective method of sampling larval fish and minnows which are too small to be collected with other sampling gear. The collection of small fish spawned in the Spring provides an index of spawning success by the adult stock.

Bass have good vision and do not trap or net easily. However, they can be sampled by operating a shockerboat (electro fishing) in shallow shoreline areas at night. Bass move into the shallows to feed after dark and an accurate appraisal of a Bass population can be made by electrofishing. A portable generator placed in the boat supplies 230 volts of AC current to three flexible electrodes that hang over the boat's bow into the water.

Fish within the field of electricity are momentarily stunned and the biologists scoops them up with a dip net. The fish are placed in tubs of fresh water where they quickly revive. After the biologist records information about each fish, it is returned to the lake to resume its frustration of fishermen.

All fish collected during a survey are listed by species, weighed, measured, and a few scales are taken. The scales are used to determine the fish's age and how much it has grown each year of its life. Knowing how fast fish are growing is very important, as rate of growth is an excellent indicator of conditions in a lake. A lake where Bluegills grow four inches their first two growing seasons would certainly be healthier than a lake where Bluegills take four years to reach four inches in length.

When the survey is completed the data are compiled, evaluated, and condensed into a lake survey report. This information will be used to answer questions such as———

(1) What's causing the water to be green colored?

(2) Is aquatic vegetation a problem?

(3) Is this a good lake for Bass, Bluegill, Walleye, Northern Pike, White Bass, Perch, Catfish, etc.?

(4) How big are the Bluegill?

(5) Are Carp, Gizzard Shad, or other rough fish a problem?

(6) Should fish be stocked?

(7) Will Trout survive and grow in this lake?

A considerable amount of expense, time, and effort goes into each survey. Approximately two weeks are spent on each lake with the objective of informing fishermen and helping to "shorten the time between bites".

If you would like survey information about a favorite fishing spot, write to one of these Regional State Fisheries Offices: Tri-Lakes Fisheries Station, R.R. #4, Columbia City, Indiana 46725; Cikana State Fish Hatchery, R.R. #4, Martinsville, Indiana 46151.

HOW OXYGEN VARIANTS DETERMINE FISH LIFE

Oxygen is sufficient for sustaining fish life to a depth of 10 feet. No oxygen exists in the deep cold water zone.

TEMP.	DEPTH	OXYGEN (ppm)
79	Surface	9.0
79	5	9.0
77	10	8.0
71	15	3.5
68	20	1.0
64	25	0.0
59	30	0.0
56	35	0.0
54	40	0.0
52	Bottom	0.0

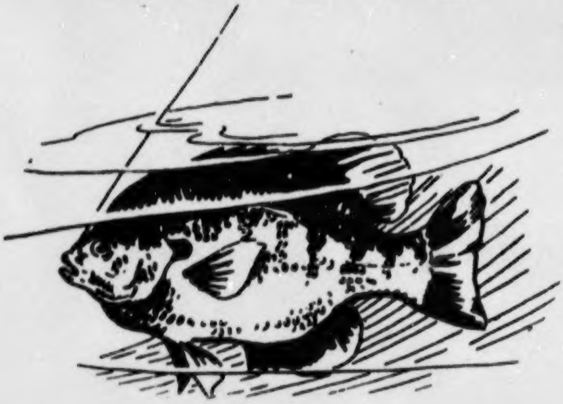
A layer of cold, highly oxygenated water is located between 15 and 30 feet. Trout would do well in this environment.

TEMP.	DEPTH	OXYGEN (ppm)
79	Surface	9.0
78	5	9.0
74	10	8.5
68	15	8.0
65	20	7.0
60	25	7.0
57	30	5.0
54	35	2.0
52	40	0.5
50	Bottom	0.0

A Valuable Fish Management Tool

LAKE RESTORATION WITH CHEMICALS

By Gary Hudson
Regional Fisheries Biologist



The primary objective of fishery managers is to produce an annual crop of desirable size sport fish for anglers. There's nothing more satisfying to a fish management biologist than to check fishermen and find them harvesting desirable-size fish.

When you consider the tried and tested tools available to fishery managers for improving fishing, chemical fish eradication projects cause the greatest concern among the public. Applying a piscicide to a lake, particularly a lake heavily developed with homes, is of interest to both fishermen and non-fishermen.

There are three ways piscicides are used to alter or manipulate undesirable fish populations. These include selective fish eradication, partial fish eradication, and total fish eradication.

Let's review each of these fish management tools, keeping in mind the purpose of every fish eradication project is to improve fishing:

SELECTIVE FISH ERADICATION

There's one species of fish found in many Indiana lakes that can be selectively eradicated. That species is gizzard shad. These fish are extremely sensitive to both rotenone and antimycin, the two piscicides most often used by fishery managers. Due to their sensitivity to these piscicides, gizzard shad can be eradicated with a dilute concentration of chemical that will not affect other species of fish.

A selective for gizzard shad is considered when 50% or more of the fish population by weight is comprised of shad. When shad are present they usually dominate a fishery by both numbers and weight. It's true that small shad are a source of forage for predator fish, such as walleye, largemouth bass, and northern pike. However; when shad reach a size larger than five or six inches in length there are few fish in a lake large enough to feed on them.

Not all of the shad in a lake will be eradicated during a selective but the removal of a high percentage of adult shad will accomplish three things:

1. Competition for microscopic food organisms (plankton) between shad and larval

game fish will be reduced. Game fish growth should increase and they will reach a harvestable size in a shorter period of time.

2. Adult shad surviving the chemical application will spawn in the spring and their young will be small enough to be eaten by predator fish. Whereas one seven-inch shad is of no value, seven one-inch shad are a good food source for most predator fish.

3. An introduction of predator fish into the fishery is possible when thousands of pounds of gizzard shad are removed. Since the fish population is not at carrying capacity immediately after a selective, walleyes, white bass, etc. have a good chance of becoming established.

Indiana's fishery biologists stock one or more species of predator fish after a selective. At Mansfield (Raccoon) Reservoir, 3 million walleye fry and 4,105 largemouth bass were stocked after the selective conducted in September, 1974. Seventeen percent of the bass stocked were adult fish capable of spawning the following spring. As a result of the selective at Raccoon, fishing has been outstanding in 1976.

PARTIAL FISH ERADICATION

A partial fish eradication is conducted when a fish population is dominated by small, thin, slow-growing fish. In most Indiana lakes where partials are conducted to improve fishing the problem species is bluegill.

A situation that has confronted fishery managers for years is a lake full of three to five-inch bluegill. These intermediate size bluegill are too small to interest fishermen and too large to be eaten by most predators. At a time when a lake needs more predators to prey on the large number of stunted bluegill, an opposing force is active. Studies reveal when bluegills reach a very high density, they eat largemouth bass eggs which reduces the number of necessary predators.

When a lake has too many forage or prey species and not enough predator fish, it is described as "out of balance". To "balance" the fishery, part of the fish population is removed. Hence the name, partial fish eradication.

When conducting a partial, the piscicide antimycin is applied at a concentrati toxic to small fish but relatively safe to large fish. A high percentage of the bluegill population can be removed in this manner. Those remaining will have more food per individual fish and should grow to a harvestable size in a shorter period of time.

Largemouth bass fingerlings are usually stocked at a density of 50-150 fish/ac to bolster the predator population within a few weeks after a partial eradication. These new predators will be present the following spring to keep the newly-hatched bluegill fry under control.

Partials are not conducted if a lake contains very many rough fish, such as carp or suckers. Adult rough fish that survive a partial could spawn in the spring and become dominant in the fishery.

TOTAL FISH ERADICATION

When fishing is poor because a lake contains very few desirable-size game fish and/or many rough fish, the only fish management tool available that will improve fishing is total fish eradication. Agreed, this is a drastic measure! But it's the only way to turn a lake around when the fish population is in really bad shape.

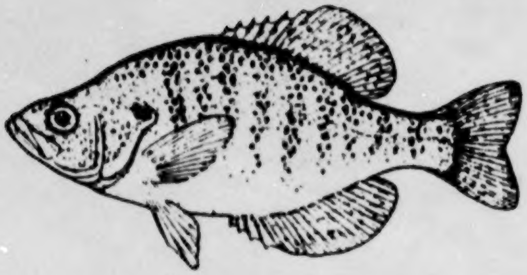
If a lake will drain, this is the most efficient and economical way of eradicating all fish. It costs nothing to open a drain valve. When the lake is almost drained the valve can be closed and the small pool of water remaining can be treated with rotenone to insure eradication of all fish. Managing a lake by drainage usually applies to southern Indiana, the area of artificial impoundments where an increasing number are drainable.

In the natural lake country of northern Indiana, total fish eradication is done with chemicals. This is quite expensive as the natural lakes are deep and the amount of chemical required to renovate a lake is determined by the volume of water and species of fish to be treated.

The amount of rotenone required to treat a natural lake smaller than 100 surface acres usually costs more than $6,000 dollars.

Fishery managers resort to total fish eradication when it's the only tool remaining that will produce good fishing.

A couple of weeks after apply [illegible] piscicide, the lake will be restocked. Fishermen can try their luck anytime after the lake has been restocked as Indiana's fishery biologists do not close lakes to fishing after renovation. Fishing should be pretty good at the end of the second growing season after renovation and if everything goes as planned the third year will offer super fishing!



Fish Stocking - Indiana Style

What does "fish management" mean to you? If you're like most fishermen, you think of fish stocking. Yet, if you ask a district fisheries biologist how his time is spent, he'll tell you very little of it is devoted to stocking.

Fish stocking is the best known, yet most misunderstood feature of modern fish management. It is not, never has been, and never will be, a panacea for poor fishing.

Stocking is only one of several very useful fish management tools or techniques available to us. In some cases, it's the most important trick in our bag. In other cases, it has no application.

There are several different kinds of stockings, each named for its intended purpose.

Initial stocking in new water can be any new lake or reservoir or an old one in which we have eliminated all fish through draining or chemical treatment.

The initial stocking is the most important stocking a lake will ever get. It will determine fishing success for years to come, establishing the lake's reputation. The habitat present in a new or renovated lake determines what species of fish it will get. While bass and bluegill are pretty much standard in Indiana, we try to match other species to habitat. Recognizing habitat for different species is an obligation of our district biologists.

When a lake appears to have everything needed for the survival of a certain kind of fish that has never been in it, that species is stocked as a new introduction. Since new introductions are made in the face of an existing fish population, high numbers of the new species must be used. Examples of new introductions are white bass, walleye and northern pike.

The most controversial type of stocking is supplemental stocking. Fisheries biologists themselves do not agree on the effectiveness and application of it. About the only things you can safely say about supplemental stockings is that they're expensive and results are unpredictable.

The whole purpose of supplemental stocking is to beef up a fish population where reproduction is low. It works well when the only limiting factor on the population is too little natural reproduction. And, of course, those species which have the most specific spawning habitat requirements are those most successfully carried by supplemental stockings. Walleyes and northern pike are good examples.

The whole supplemental stocking idea falls apart when spawning success is not the factor holding a population down. In many lakes we have a seeming abundance of bass fry produced. Yet, increased numbers of adults never result. Why? One or more mortality factors limit development of those populations. This can run the gamut from excessive predation on young fish to stiff competition for food from other species.

Maintenance stocking is a slightly different approach. Where supplementals are intended to augment low natural reproduction, maintenance stockings are made where no natural reproduction occurs. Populations of musky, walleye, striped bass and northern pike are frequently established and carried this way.

The practicality of maintenance stocking is limited to those species which can be literally mass produced at relatively little cost. Northern pike fingerlings can be inexpensively produced by simple pond culture.

Walleyes are also inexpensive to produce in high numbers (literally millions) if broodstock is readily available. They're hatched in a jar culture unit that can be put together for a few hundred dollars and are usually stocked as fry. Eventhough walleye fry survival is low, only a few have to survive at the stocking rates used (3,000 to 5,000 per acre).

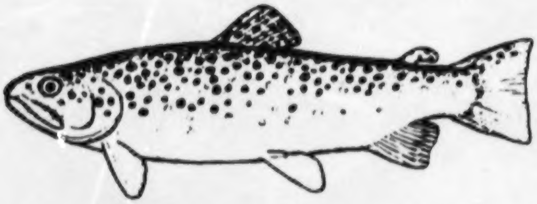
Natural reproduction of musky and striped bass is low to non-existent in most areas. Populations of these species often must be maintained through hatchery programs.

Put-and-take stocking is the most costly stocking we get into. It amounts to stocking a catchable size fish in front of the man with the rod and is usually confined to trout. The objective of any put-and-take program is to get the highest percentage return (catch) of the stocked fish that's possible. For this reason the fish are stocked just prior to an opening day. Natural mortality is thereby minimized and the maximum number is available to fishermen.

Stocking will always be an integral part of any fish management program. And, used at the right time and place, it will continue to be a big hammer in our management tool box. We're hoping for greater public understanding of why we don't swing it indiscriminately.

DIVISION OF FISH AND WILDLIFE

INDIANA DEPARTMENT OF NATURAL RESOURCES



What You Ought to Know About Fish Management

Joseph L. Janisch
Fisheries Biologist
Division of Fish and Wildlife

Fisheries biologists have been trying to understand the psychology and behavior of fish for a long time. The biologist has learned some things during the last 35 years, but even he admits there is much yet to be understood. Various management techniques have been developed and we know more about population behavior, but the biggest hurdle yet to be overcome is the fisherman's attitude toward fish management.

Many of today's fishermen are still living in the 1940's when fish management meant supplemental stocking and liberal regulations. Since then, times have changed, people have changed, fishing methods have changed, and the biologist has disproven many original concepts.

This 15-question quiz will test your fisheries knowledge and your understanding of the principles of warmwater fish management. The quiz will let the fisherman know if he is up-to-date on fish management and recognizes modern fish management problems.

1. Does the general tax dollar pay for fish management in Indiana?
2. Are public waters in Indiana the only waters managed by State fisheries biologists?
3. Is aquatic weed control a useful fish management tool?
4. Is stocking the No. 1 tool of the fisheries biologist?
5. Is the overharvest of a fish population a real fisheries problem?
6. Does fishing pressure really affect a fish population?
7. Does overharvesting a largemouth bass population affect bluegill?
8. Can a lake really be fished out?
9. Does it help a fish population when you release a six-pound largemouth bass?
10. Does supplemental stocking a reproducing bass population improve bass fishing?
11. Do 10% of the fishermen really catch 90% of the fish?
12. Is the largemouth bass the best predator for controlling bluegill?
13. Is the largemouth bass the best predator for controlling most forage fish?
14. Is habitat important to fish population?
15. Are fishing regulations and fish management practices based on biological studies?

Here are the answers:

1. No! Fish management is solely funded by the purchase of hunting and fishing licenses. There is no general tax money involved in fish management activities.

2: Yes! Since the fisherman pays for fish management programs, we are obligated to manage only those waters where the public is allowed to fish. Since a fishing license is not required to fish private waters in Indiana, the State fisheries biologists are not responsible for their management.

3. Yes! Besides having aesthetic value, weed control enables the biologist to eliminate large amounts of vegetation that would normally hide small fish. When cover is eliminated, larger fish have an opportunity to prey on the small fish, keeping their numbers in check. A total weed eradication program is never conducted because some weeds must be left as natural habitat.

4. No! Fish stocking is a fish management tool, but it is not No. 1. This is a general misconception that many fishermen have because of programs conducted during the 1940s. We have proven time and time again that stocking fish into an existing, reproducing population of the same species does nothing to improve the fishery. As a matter of fact, it is a very wasteful and expensive program.

5. Yes! Creel surveys have shown that fishing pressure has a significant effect on fish populations. In most cases the largemouth bass fishery is affected the most.

6. Yes! Because of increased fishing pressure, fish populations can be overharvested. Indiana recorded fishing pressure in 1974 between 150 and 500 hours per acre per year. This compares to 1965 when fishing pressure ranged between 50 and 100 hours per acre per year.

7. Yes! Overharvesting largemouth bass has a direct effect on bluegill populations. If a bass population is overharvested, a stunted bluegill population will occur. Bass overharvest is the No. 1 cause of stunted bluegill populations in Indiana.

8. Yes! Only until a few years ago the answer to this question would have been no. In today's world, because of the increasing fishing pressure, a fish population can literally be fished to the point where fishing success is almost zero. This means there may be a few fish in a population but their numbers are so low that for all intent and purposes the lake has been fished out.

9. No! Most fishermen would say yes to this question, thinking that the six-pound bass is an excellent spawner and therefore should be released back into the fishery to reproduce. This is not the case. A two-pound bass is a much better spawning adult than a six-pound bass. Once a fish reaches the five-to-six pound class it can no longer make a significant contribution to the re-population of a lake, pond, or stream. It is much better to release the two-pound fish and take home the six-pounder.

10. No! The key to this question is a reproducing bass population. If a bass population is successfully reproducing, additional bass would have to compete with the existing population for the same food and space. The results are always poor and the fishery is never improved.

11. Yes! This demonstrates the fact that most of the fish are caught by only a few fishermen. The actual percentage of fish caught by fishermen varies from 90% of the fish caught by 10% of the fishermen to about 80% of the fish caught by 30% of the fishermen. Within this frame of reference it is true that most of the fish are caught by only a few fishermen.

12. Yes! Of all the freshwater predators that exist, the largemouth bass has been shown to be the best for controlling bluegill populations.

13. No! While the largemouth bass is the best predator for controlling bluegill, he is not the best predator for controlling many other types of forage fish. For example, gizzard shad, which is an abundant forage fish in most of our reservoirs and rivers in Indiana, is not effectively controlled by the largemouth bass. In many of our reservoirs the largemouth bass is so inefficient at controlling shad that the shad populations become unbalanced and compete with young bass for food.

14. Yes! Habitat means a variety of things to a fish population: spawning sites, good water quality, cover and food. Each of these is a different type of habitat. If any one was limited it could literally mean the end of a fish population or the decline of a particular species. Stream fisheries are affected the most by the destruction of habitat. Stream channelization, siltation and pollution are the three ways that most fish habitat is lost. Without habitat there is no fishery.

15. Yes! Indiana's fishing regulations are based on biological studies of fish populations. A good example is the 14-inch largemouth bass size limit. Bass population studies, mortality studies and creel surveys conducted on a variety of lakes and reservoirs in Indiana and throughout the Midwest, showed that fishermen were removing more largemouth bass than the fish population could stand. Something had to be done to slow down that harvest. The choices were a quota system, a smaller daily bag limit, a size limit or a closed season. From a management standpoint, after weighing all the alternatives, it was decided to impose a size limit.

If you correctly answer nine questions consider yourself average. But don't be too pleased, because your fish management abilities need improving.

If you answer 13 or more questions correctly you have a real understanding for the principles of modern fish management.

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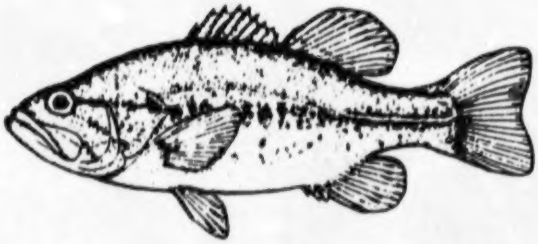

What Causes "FISH KILLS" in Indiana Lakes and Ponds?

Division of Fish and Wildlife
Indiana Department of Natural Resources

Fisheries biologists with the Indiana Department of Natural Resources often get reports from pond owners that fish are dead or dying. By the time those reports are received, it is too late to stop the die-off. But many fish kills can be anticipated and prevented.

Basically, there are three times during the year when fish kills occur.

In the Spring, fish are in their poorest condition of the year. Fook intake has decreased over the cold Winter months resulting in weight loss. Extra stress is placed on the fish as algae begins to grow and decompose in early spring. This causes a decrease in the oxygen level of the water. Larger fish, because of their greater need for oxygen, are often the first to die from oxygen shortage, followed by the smaller fish.

Spring kills are most common in lakes with a slow-growing, stunted fish population. Fish in good physical condition at the start of Winter are better able to cope with harsh Winter conditions and thus are in better shape come Spring.

Spring kills cannot always be prevented, but treatment of early growths of algae can help.

Proper watershed management is important because fertilizers and herbicides that wash in from adjoining agricultural land may contribute to die-offs.

In Summer, decomposing algae is the most frequent cause of fish kills. The fast-growing algae may cover an entire lake in only a few days. There may be a rapid die-off of the plants after a cold rain or after several days of cloud cover. When this occurs, photosynthesis and oxygen production stops and decomposition of the algae further reduces the oxygen level. Treatment of the algae before it becomes a problem is the best preventive measure.

In Winter, a lake's oxygen level is dependent on the passage of light through the ice. The sunlight works in co-operation with tiny aquatic plants to produce dissolved oxygen. If the surface ice is cloudy or snow-covered, sunlight cannot penetrate it. Oxygen production stops.

Without this constant replenishment of oxygen, the combination of fish's respiration and decomposing organic material may reduce the oxygen content to intolerable levels. Cutting holes in the ice is no help. The only worthwhile measure is to remove the snow from the ice. Snow-covered ice is particularly harmful to fish in shallow, fertile, weed-filled ponds.

Pond and lake owners also can help prevent fish kills by restricting the harvest of largemouth bass from their waters. The predator bass prevent the water from becoming overrun with small fish, thus reducing the chances for a die-off because of overcrowded conditions.

If you experience a fish kill, it is important to determine if the kill was total or partial. This can be done by pulling a seine through the pond. If largemouth bass are [illegible]led, particularly bass ten inches and larger, restocking may be necessary. Once you [illegible] a feeling for the condition of the fishery, contact your district fisheries biologist for his recommendations.

FNR-69
April, 1977

forestry & natural resources
WILDLIFE AND FISHERIES

Fish Kills in Indiana—Their Causes and Prevention

by Herbert C. Krauch, Extension Specialist in Wildlife

For anyone who has a stocked pond—and there are thousands in Indiana—fish kills can be quite a problem. The condition called "fish kill" occurs when a number of fish in a given body of water die from a specific cause. Among these causes are chemical pollution, water quality (pH, hardness, oxygen supply, etc.), old age, physical disturbance, oxygen depletion, parasites and/or disease.

Often, fish kills can be anticipated and measures taken to prevent them.

The most common cause of fish kills in Indiana ponds is oxygen depletion. Oxygen depletion results when conditions create a greater demand for oxygen than the aquatic environment can produce. Oxygen depletion can occur in both winter and summer.

Winter kill

The conditions which produce oxygen depletion in winter are quite different from those which result in summer kills. The results of a winter kill are seldom noticed until spring when the ice melts. Then the dead fish, often the larger ones, are seen washing up along the edge. The large fish die first, because they require more oxygen, and will suffocate first.

During winter, most ponds are covered by ice. The oxygen supply under the ice depends on the passage of light through the ice and the resulting production of oxygen by the tiny algae in the water. If the ice is snow-covered, sunlight cannot penetrate and the plants cannot produce oxygen. Just an inch of snow can shut out as much as 90 per cent of the light; and five inches will shut out about 99 per cent.

The existing oxygen is then gradually used up by the respiration of the fish and by natural decay processes. If the snow remains on the ice long enough, the fish will suffocate.

Generally, not all the fish are killed. Some are more resistant to low oxygen levels than others. In addition, poor conditions may not exist uniformly throughout the pond. So, the result may be that the larger fish, such as bass, die, leaving the smaller, immature fish in the pond. This creates conditions further unbalancing the pond population very quickly.

Preventing winter kill

Pond design is important to preventing winter kill. In Indiana, ponds should be at least eight feet deep over at least 25 per cent of the pond area. Greater depths are even better.

If, however, an eight foot depth isn't possible, a six foot depth over at least half the pond is an alternative. Deepening the pond and/or removing build-ups of dead and decaying organic matter from the pond will help preserve the oxygen.

Removing snow cover from at least 50 per cent of the pond surface may help. But, unless the ice is thick enough to hold a person or small tractor, this can be very dangerous. Be sure the ice is sufficiently thick! Chopping holes in the ice won't help.

Summer kill

The most common cause of summer fish die-offs is the same as winter kill—oxygen depletion. But the causes of depletion may be more complex than with winter kills. Summer depletion can result from oxygen removal by excessive quantities of plants, animals or decaying organic matter.

This can be caused by overstocking, overfeeding, over fertilization, pollution from barns, feedlots, improper septic drainage, or chemical treatment of aquatic weeds during the critical months—June through September.

Another common cause of summer fish kills occurs when a dense growth of submerged aquatic plants or algae in a pond dies suddenly from natural causes or from herbicides.

The decay process from the dead plants may use up the oxygen in the water. This type of summer fish kill almost always happens about sunrise, when the dissolved oxygen is at its low point for the day.

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Another condition leading to summer fish kill, and related to the plant die-off, is high water temperatures. During July, and especially in August, water temperatures in ponds may reach 85-95°F. Water can hold much less oxygen when its temperature is above 80°F.

When overcast skies persist for several days, while temperatures are high and winds are calm, a fish kill may occur. Plants cannot produce sufficient oxygen at reduced light levels and calm weather reduces the exposure of water to oxygen in the air. Therefore, the dissolved oxygen may disappear entirely.

Signs of oxygen depletion

1. Large numbers of fish are seen at the water surface gulping air at night or early in the morning. When disturbed they dive, but quickly return to the surface.
2. If oxygen depletion is not severe, fish are at the surface in the early morning but go to deeper water as oxygen builds up during the day. This may continue for several days. If the owner is observant it will give him time to take corrective action.
3. Although feeding is not recommended in Indiana, if fish are being fed they will suddenly stop eating.

Prevention

Conditions leading to fish kills from aquatic plant die-offs and temperatures can be alleviated by controlling rooted aquatic vegetation and algae. When plants are dense, chemically treat only a portion of the pond at one time and allow that part of the vegetation to decay before further treatment.

In new pond construction, a bottom-water overflow outlet will reduce the chances of a die-off. Briefly, this type of outlet releases water from the pond bottom. Contact the local Soil Conservation Service office for details on this construction.

Emergency treatment is suggested if signs of oxygen depletion are observed. Steps should be taken immediately to prevent losses.

Physical treatments

1. Flush the pond with fresh aerated water from a well or adjacent pond.
2. Spray water from a 2 to 3 foot depth into the air with a pump.
3. In small ponds, add oxygen by stirring the surface water vigorously with an anchored outboard motor.

Chemical treatment

There is a chemical treatment to alleviate oxygen depletion temporarily, but this should not be attempted without obtaining advice from a fisheries biologist.

Emergency treatments will help alleviate oxygen depletion. However, the key to preventing oxygen depletion is first, proper pond construction, and secondly, proper pond management. After the emergency has passed, find and eliminate the cause of oxygen shortage.

Other factors causing fish kills

Fish kills can also be caused by organic pollution, chemical run-off and disease. Organic pollution from barnyards, feedlots, and faulty septic system drainage consumes oxygen as it decays and quickly depletes oxygen content in the pond. Fish kills from these sources of pollution often occur after a rain has washed quantities of these materials into the pond.

Steps should be taken to prevent all organic waste from entering ponds. Preventive measures include properly installed tiling, grading, and/or diversion ditches.

Pesticides used on farm crops or in home yards and gardens may wash into a pond during heavy rains and cause a fish kill. Fish may die from the direct effect of the chemical.

Caution should always be exercised in the selection of pesticides and in the time of application.

In the spring or summer a few fish may be found dead along the shoreline. Such mortality is often the result of natural causes. The natural resistance of fish to disease is lower in the early spring than at any time of the year. Larger fish seem to be more susceptible, but, it may also be a simple case of old age. Heavy parasite infestation may also be a cause of death.

There are other less common causes of fish kills, but those dealt with here will account for the great majority.

Restoring the balance after a fish kill

Generally, to correct the population imbalance resulting from a fish die-off, regardless of cause, it is best to renovate the pond. That is, kill the remaining fish, either with a chemical or by draining, and restock.

If there is a question concerning the severity of the kill, contact the district fish management biologist, Indiana Department of Natural Resources, for advice on checking the pond's fish population.

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Your Fishing License Money at Work

What has the Indiana Department of Natural Resources done for the fisherman? It costs the fishermen of Indiana $605,000 to operate the Fisheries Section of the Division of Fish and Wildlife. What does the fisherman get for that license he must buy to fish public waters?

Indiana's fishing public supports eight district fisheries biologists, two research biologists, two Lake Michigan biologists and four state fish hatcheries. Fishermen pay the salaries of twenty-three professionally trained fisheries biologists and purchase their equipment and maintain their fishery stations. What does the fisheries biologist provide in return?

During 1976 fisheries biologists conducted fisheries surveys on 98 lakes throughout the state. Some of those lakes surveyed were Webster and Wabee Lake in Kosciusko County; Willow Slough, Newton County; Shakamak Lake, Greene-Sullivan County; Mansfield Reservoir, Parke County; Bowen Lake, Clark County; Mississinewa Reservoir, Wabash County; Brush Creek Reservoir, Jennings County and Brookville Reservoir, Franklin County.

What is a fisheries survey? Fishery surveys are designed to determine the quality of the fishery. Once the data has been assimilated, the biologist will determine if fish management is needed. If management is needed, the biologist will make his recommendation then carry out the work.

Examples of fish management are fish attractors constructed at Salamonie Reservoir during 1976, a partial selective for gizzard shad conducted at Willow Slough State Fish [illegible] Wildlife Area, the renovation of Boone's Pond in Boone County, and the introduction of white bass at Versailles Reservoir, Ripley County.

An essential part of any fish management program is a good hatchery program. Our stocking policy is that largemouth bass, bluegill, redear and crappie are to be stocked once and once only in new impoundments or renovated waters. These species are not supplementary stocked in state waters. Natural reproduction of largemouth bass and bluegill is sufficient to maintain a fishery.

Those species which are supplementary stocked in our lakes and reservoirs in the state are species that do not reproduce naturally. Those species are northern pike, walleye, musky, chinook salmon, coho salmon, rainbow trout, brown trout, and striped bass. In most cases lack of spawning habitat is the reason. Without a good hatchery system to propagate the species, they would not exist.

During 1976 your fish hatcheries produced 85,000 northern pike. They were stocked in J.C. Murphy Lake at Willow Slough State Fish and Wildlife Area, Hardy Lake in Scott County, Brush Creek in Jennings County, Versailles Lake in Ripley County and Wolf Lake in Lake County. In addition 19 million walleye fry were stocked in Cataract and Mansfield Reservoirs and Lake Wawasee. Over 43,000 channel catfish were stocked in public lakes along with 18,000 striped bass and 1,800 musky. We also stocked 100,000 largemouth bass in new water. New fish populations were established at Atterbury State Fish and Wildlife Area in Johnson County and Potato Creek State Recreational Area in St. Joseph County.

For those fishermen who enjoy catching trout and salmon, your coldwater hatchery system stocked 178,000 steelhead, 149,000 brown trout, 38,000 chinook and 210,000 coho salmon. The put-and-take trout program amounted to 65,000 rainbow trout. These were stocked in 23 streams and 20 lakes in northern, central and southern Indiana.

Indiana's fisheries research biologists directed their studies toward bass and bluegill management. During 1976 your fish research biologists worked on bluegill population dynamics in the natural lakes region. We looked at the effect fishing pressure has on bluegill populations.

The current 14-inch largemouth bass size limit, in effect since 1973, has been studied for the last three years. This project has been the backbone of most of our bass and bluegill management.

The third major project was research into the white amur problem in Indiana and its effect on our warmwater fish populations. We need to know if the introduction of the white amur will help or hinder bass and bluegill fishing.

Every fisherman should remember that good fishing is no accident. It takes work and a good program. The purchase of a fishing license is the first step to improved fishing.

DIVISION OF FISH AND WILDLIFE

INDIANA DEPARTMENT OF NATURAL RESOURCES

WHAT IS HAPPENING TO OUR STREAM FISHERIES?

What has happened to Indiana streams? Why can't I catch fish like I use to?

These are questions which many Hoosiers direct at the Division of Fish and Wildlife about the quality of Indiana stream fishing.

The answers to these questions are easy to come by but the solutions are not what most Hoosiers want to hear. The typical solution voiced by the public is "stock fish". But the biologists know that stocking fish in a stream is like looking for a pot of gold at the end of the rainbow.

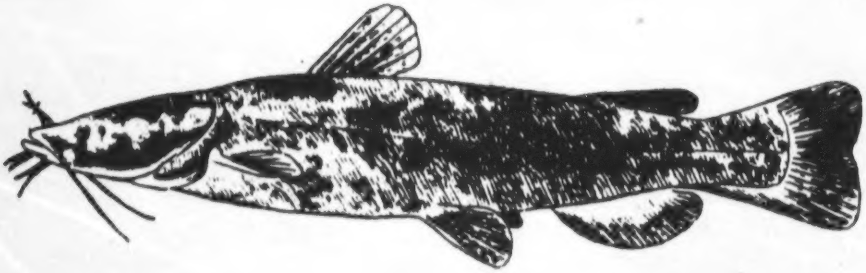
The real problems are pollution and habitat destruction. Correcting these problems is the solution to improving the fish populations in Indiana streams.

Pollution in most instances is localized but loss of habitat is wide spread and the direct result of poor soil management, construction in flood plains, channelization and dams. Channelization and other related projects have removed more habitat and done more to destroy Indiana streams than any single factor.

The fisheries biologist cannot manage the fishery if he has nothing to work with. It takes good habitat to produce a good fishery.

What is good habitat? Good habitat means cover, overhanging branches, trees, stumps and logs. That's where fish live and that's what they need to survive.

The best fish management for a stream is to leave it natural. Before Indiana will see any improvement in its streams and their fish populations, Hoosiers will have to change their ideas about channelization, continue to improve water quality and make an all out effort to restore stream habitat.



INDIANA DEPARTMENT OF NATURAL RESOURCES

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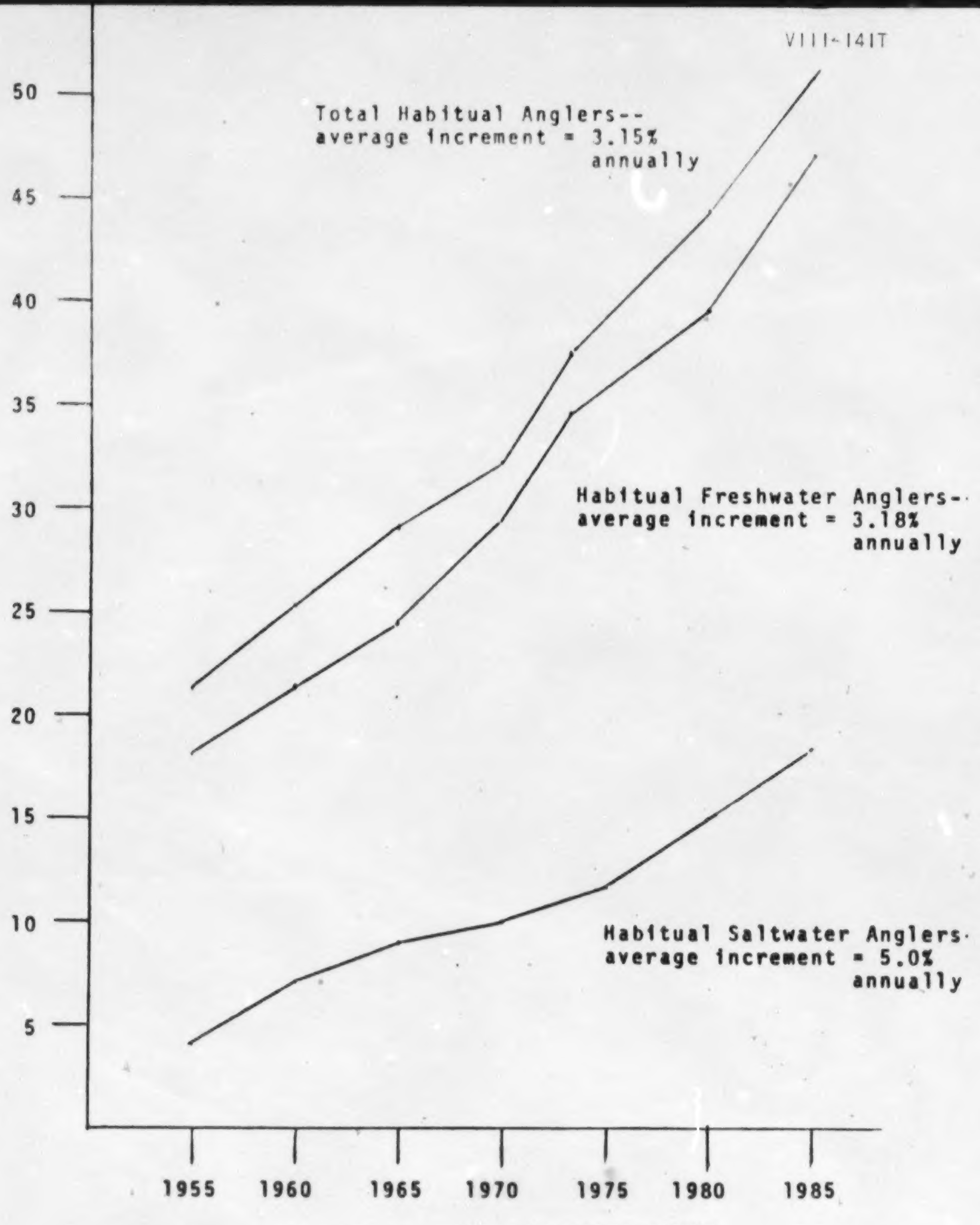
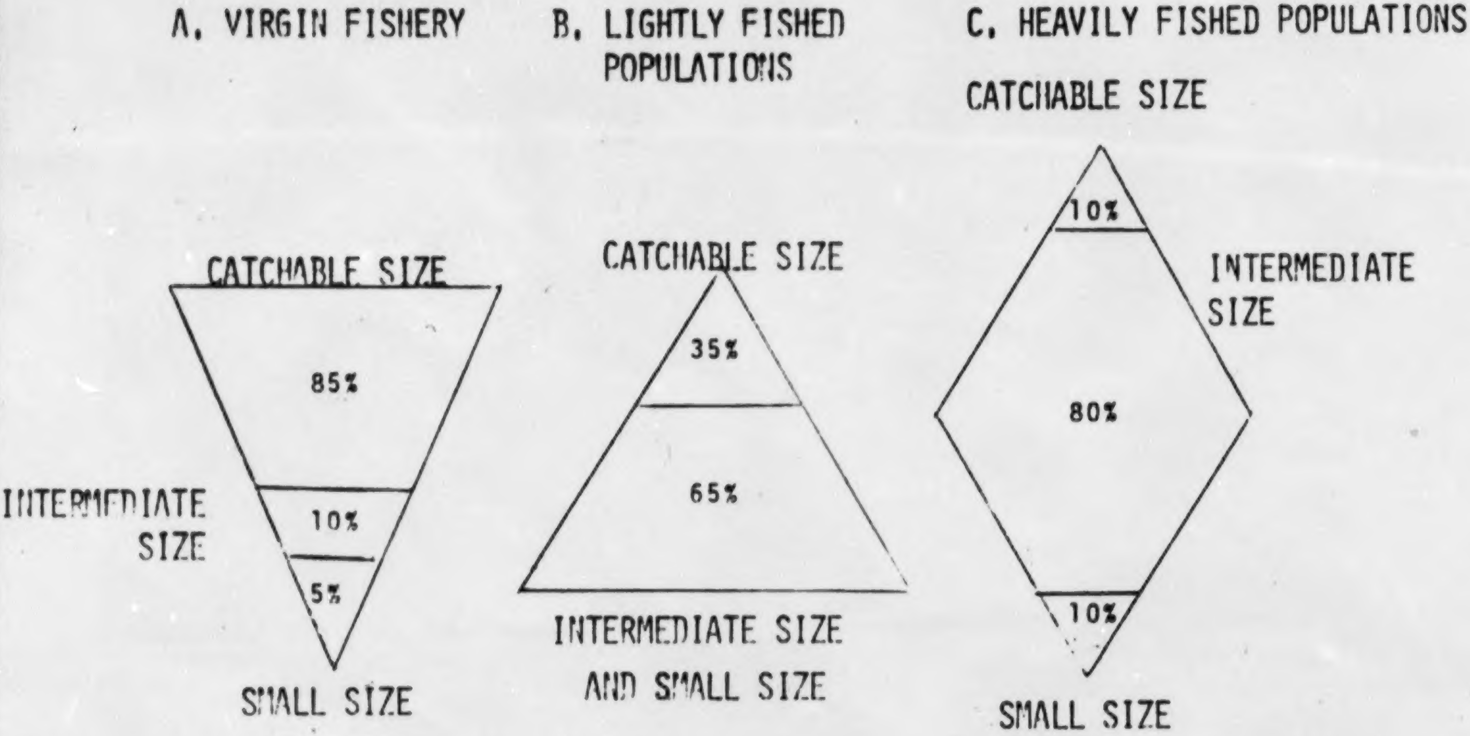


TRENDS IN ANGLING PARTICIPATION

THE EFFECT OF FISHING ON FRESH WATER FISH POPULATIONS


A. VIRGIN FISHERY
CATCHABLE SIZE
85%
INTERMEDIATE SIZE
10%
5%
SMALL SIZE
B. LIGHTLY FISHED POPULATIONS
CATCHABLE SIZE
35%
65%
INTERMEDIATE SIZE AND SMALL SIZE
C. HEAVILY FISHED POPULATIONS
CATCHABLE SIZE
10%
INTERMEDIATE SIZE
80%
10%
SMALL SIZE